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The Great Meteor of March 24, 1933

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The meteoric display of March 24, 1933, over New Mexico and adjoining states may be recorded as an important event in the history of meteoritics; not only because of its great magnitude, but also by reason

FIGURE 1.
Picture taken by Mr. Chas. M. Brown while meteor was in flight. Kodak facing altitude of about 40° as meteor approached the zenith.

of the good fortune which attended the use of several cameras for its recording, thus contributing in a unique way to our knowledge of meteoric phenomena.

For the first time we are able to present satisfactory photographs of

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a meteoric cloud of great magnitude. These photographs were taken from several locations such as to render possible reliable deductions as to height, size, luminescence, and drift. But most important, we are able to present a photograph of the meteor in motion, taken under conditions which made possible satisfactory calculations as to the magnitude and form of the train as it was left in the immediate wake of the projectile and the great luminous spheroid which enveloped the meteorite at the instant the picture was taken.

In a ranch house located in a narrow valley, some 25 miles southwest of Clayton, New Mexico, Chas. M. Brown, locally known as Charlie, foreman on the Lyon ranch, was just ready to sit down to breakfast as the clock struck five on that eventful morning. The meteor flashed, lighting up the sky like midday.

The No. 2 A Brownie folding pocket kodak lay on the radio to the right and back of Charlie's breakfast chair. It was not there for any special purpose only that in a small crowded ranch house it had to be somewhere and this chanced to be its place. It was seldom used but happened to have a partially exposed roll in it that morning. The chores had been done and breakfast was called. Brown approached the table; but just as he did so the sky suddenly lighted.

At the first flash he grabbed the kodak and made for the door, opening the Brownie as he went. When he reached a point about eight steps from the door he was clear of the trees. He trained the instrument on the approaching meteor and snapped the shutter. When he again looked up the meteor was disappearing over the house.

I had Mr. Brown go through the motions again just as he had done that morning, and found it required eight seconds for him to get the picture, from the time the light first flashed.

The writer was both fortunate and unfortunate in his location at the time this event transpired. He chanced to be at Clovis, New Mexico, approximately 130 miles south of the meteor's course. This location should have afforded an excellent view but for the fact that the northern sky was obscured by clouds. From Melrose, 25 miles to the west, the meteor was seen to emerge from behind this cloud bank making a brilliant display. Starting from this location I was enabled to interview witnesses on all sides of the meteor's terminus on the day of its fall. Thus my first notes were free from the bias which may have entered into those which were gathered later after witnesses had been reading false newspaper reports.

All data used in the preparation of this paper were obtained from witnesses by personal interview in the locations from which the observations had been made, or from photographs. Witnesses were interviewed at points in New Mexico as follows: Melrose, Cantara, Krider, La Lande, Gallegos, Mosquero, Solano, Roy, Mills, Springer, Wagon Mound, Las Vegas, La Cueva, Buena Vista, Sapello, Raton, Hot Springs, Albuquerque, and Clayton; in Colorado: Trinidad, Walsenburg, Pueblo, Colorado Springs, Denver, La Junta, and Burlington; in

Kansas: Kanorado, Beardsley, Oberlin, Liberal, Syracuse, Johnson, Pratt, Kingman, and Wichita; in Texas: El Paso, Odessa, Lubbock, Plainview, Tulia, Texline, Dalhart, Amarillo, Canyon, Perryton, and Stratford; in Oklahoma: Guymon, Knowles, Logan, Texhoma, Hooker, and Optima.

The Light Phenomena

The light phenomena of the meteor of March 24 may be conveniently considered under two divisions: The moving fireball or fireballs, and the after-glow, which came from the cloud or persistent train which remained in the meteor's wake.

The various witnesses disagree as to whether there were one, two, or several fireballs. From Melrose and Ft. Sumner, witnesses described a cluster or procession of from three to several fireballs scattered along a length of about one degree. Mr. Bishop of Canyon, Texas, declares there was only one ball until it reached a point 22° west of north from him where it separated into two distinct parts which appeared to travel side by side to the finish. Several others, particularly those who saw it from long distances, report more than one fireball traveling in a group. It is probable that in the latter part of its course the meteor consisted of a cluster but for those who were near, the light was so brilliant as to render the detection of the separate units impossible; while for those farther away the various components became distinguishable.

The majority of witnesses who were within 50 miles of its terminus indicate that one or more "explosions" occurred during the meteor's course and that after the last such bursting two or more fireballs were seen gradually to fade into redness and then to disappear. Mr. McClure, two miles N.W. of Mills, New Mexico, saw a pillar of fire rise from the eastern horizon to an altitude of about 35° or 40° where it parted, sending one smoking missile past him on the north. Thinking this was going to strike his barn he did not notice any other result of the "parting" except some patches of cloud that remained for "some time afterward." Drawings by Victor Martinez of Wagon Mound, New Mexico, also indicate a bursting into three parts near the terminus of the meteor.

Several factors may be responsible for discrepancies between the reports of various witnesses regarding the behavior of a meteor at its finish: Let us suppose a meteor divides into four parts at its last bursting which takes place at, let us say, an altitude of 15 miles. The four resulting fragments have sufficient velocity so that they continue to burn for a distance of one or two miles; but they are of different sizes and their lights are of different intensities so that for persons as near as 30 miles, all would be visible, while for those 70 miles away only the two largest could be seen. From a distance of 125 miles no individual fragments could be distinguished, but the meteor would appear simply to emit a puff and then vanish.

Again, if a meteor consists of several very brilliant fireballs, each of a

sufficient brilliance to dazzle and almost blind the eyes, as seems to have been the case with the subject of this paper, they may, as pointed out in a preceeding paragraph, appear as one to observers within a certain radius, while for those at greater distances such that they cease to produce the blinding effect, they may be distinguishable as separate lights, providing they are separated from each other by sufficient distances. Finally, however, as we recede from them a distance will be reached from which their spatial separation will not be sufficient to enable the eye to resolve them into separate units and they will appear as one. The latter condition is well illustrated by the headlights of an automobile approaching from a distance. Again, the distribution of the various units of a multiple meteor may render them distinguishable to observers from certain angles, while for those in a different position two or more would fall into the same line of vision and appear as one.

We must also allow for differences in optical efficiency on the part of observers as well as interest, effort, fear, and other psychological factors.

After going over all of the evidence, I am led to believe that, subsequent to the bursting depicted by Bishop and other witnesses, we had at least a double and perhaps still later a multiple meteor. According to our survey the spherical cloud which was sketched by Bishop is the same as that photographed by Brown. It will be noted that there are two prominences on the forward end of the spherical ball in the Brown photograph. It seems reasonable to conclude that these are the points from which two fragments are about to emerge.

A careful study of the Brown photograph together with a large number of related data was made by Mr. J. D. Figgins, Director of the Colorado Museum of Natural History, and the writer. We conclude that the most satisfactory explanation of this photograph is to be found in assuming that the meteor was produced by a huge meteorite of unsymmetrical form such that when it encountered the atmosphere it produced results analogous to those produced by an irregularly shaped pebble thrown into the water, describing the very erratic course recorded in the more distant portion of the Latham photograph. As it recovered from the first shock of impact, it acquired a certain equilibrium traveling in the spiral course so graphically shown in the Brown photograph. By the time the last explosion occurred the mass had been so mutilated by its aerial conflict that it was rent asunder, producing the two missiles depicted by Bishop, as fireballs which indeed they continued to be for many miles.

The large incandescent spheroid shown in the photograph presents a difficult problem for interpretation. As has been previously stated, this picture actually represents an object no less than six miles in diameter. What was the nature of this spheroid?

We may safely assume that the meteorite, as it drove its course earthward, carried a rapidly accumulating column of air in front of it. The core of this column would be very effectively insulated. This buffer of air, between the increasing resistance in front and the terrific drive

from the rear, was compressed until, at the instant of its maximum stress, a temperature was developed in its axial core directly in front of the meteorite as great as or perhaps greater than that which was attained where the air-blast impinged on the face of the stone.

It has also been suggested by Dr. E. J. Workman, University of New Mexico, that a difference in electrical potential between the invading meteorite and the earth may result in electrical discharges between the meteorite and the surrounding air accompanied by enormous production of heat. An examination of the fragments thrown down while the fireball was in transit indicates that the temperature in the vicinity of the meteorite was sufficiently high so that discharged fragments were seared over by a fusion crust within a brief fraction of a second.

This severe temperature was productive of much ionization and perhaps even more violent forms of atomic disintegration which spread outward with the violence of an explosion—not of the meteorite—but of compressed air. This process temporarily relieved the pressure and the meteorite sped onward, gathering another air cushion as before. There may be one or several such explosions during a meteor's flight before its spatial momentum is reduced to the point where it ceases to be able to generate sufficient heat for the process. According to the best witnesses there were four such explosions or flashes exhibited by the subject of this discussion.

It is the writer's belief that the disruption of meteorites during their passage through the atmosphere is due to these violent explosions in front of the moving body, together with the electrical discharges between the meteorite and its enveloping air envelope rather than to the various other causes which have been assigned by previous writings on the subject.

The After-Glow and the Cloud

A most puzzling aspect of this meteor was the after-glow which various witnesses reported as "as bright as the sun"; "much brighter than the moon"; "like burning magnesium"; "like that produced by a short in a power line"; "too bright to look at," etc. Mr. Walker, the railroad agent at Springer, New Mexico, stepped outside his office 30 minutes after the passage and found the cloud bright enough to cast a shadow against the eastern side of the depot.

It has been argued that this glow was due to light from the sun which reached this stratosphere cloud and was reflected to the observer. The writer must admit a prejudice in favor of this explanation during the early part of his survey and will confess that he refused to admit the possibility of a self-luminous cloud for longer than a very few minutes after the meteor's flight.

However, when Professor A. W. Recht, astronomer at Denver University, calculated the position of the sun at the moment of the meteor's passage, he found that the cloud could not have received direct sunlight unless its elevation had been 79 miles or more. No part of the visible

cloud was ever above 51 miles and the greatest luminescence was below 35 miles. Hence we were compelled to admit that the cloud was self-luminous.

The photographs also prove that the cloud emitted light at least as late as 5:30. In Figure 2 we see a large area of the sky illuminated. This picture was taken at 5:15 with the camera facing 30° south of east.

FIGURE 2.

The luminous train of meteor as it appeared from Timpas, Colo., at 5:15 A.M. Distance from photographer about 146 miles to middle of cloud. Lens 3½-in. focus. Photographer C. R. West.

The sun will appear 45 minutes later almost exactly due east. The picture clearly shows an illuminated area about the cloud which could not come from the sun. The Brooks picture was taken facing a direction 25° north of east. The dawn shows clearly in the right end of the picture; but no shadow is cast on any part of the clear white meteor cloud. It appears to be self-luminous, as indeed Mr. Brooks, the photographer, insists it was. He, being accustomed to the use of magnesium light, compared it with the burning of magnesium. Bear in mind, this picture was taken almost 30 minutes after the meteor passed. Scores of men and women who saw it declare the cloud was luminous for at least 45 minutes.

The temperatures which are assumed to exist at high altitudes seem to render it quite improbable that this luminescence was due to incandescent particles of the meteorite. It is much more probable that it was, in accordance with the conclusions of Trowbridge,[1] due to ionization of the atmosphere or meteoritic dust, or both.

The texture of the stones from this fall is such that it would have disintegrated rapidly when subjected to great vibration or strain. Indeed, it appears to be like volcanic dust or tufa more than like anything else. The immense cloud which continued to float in the sky long after all luminescence had disappeared was doubtless composed of dust from the disintegrated meteorite.

It is regrettable that in view of our many modern facilities for com-

munication and rapid travel, both on land and in the air, there has not yet been a serious effort put forth to explore and analyse these meteoritic clouds, several of which are produced within reach of civilized man each year. Such an exploration would no doubt throw important light on the composition and magnitude of the meteorites which produce them.

In a case of the kind under discussion it would have been possible also to carry out a project of spectrum analysis with a considerable degree of success, even though no advance preparation had been made.

FIGURE 3.
Portion of cloud from Timpas, Colorado, at 5:25 A.M.
Lens 7½-inch focus. Photographer C. R. West.

This has lead me to suggest that there should be established a Laboratory for Meteoritic Research which, in addition to other activities, should serve as a clearing house for information on important meteoritic phenomena and thus coördinate the work of many institutions. In this instance, telephonic communication could have brought into use instruments in several state institutions, resulting in important additions to our knowledge in this field. It has seemed to the writer that meteor clouds offer some of the greatest opportunities for fruitful investigation to be found in the field of meteoritics, and, fortunately, in this instance we have photographic proof of the cloud's magnitude.

When a cloud more than 200 miles in length and 3 miles in diameter throughout 100 miles of this length is left in the wake of a meteor one half-hour after its passage, there is little use to dispute the contention that enormous quantities of meteoritic matter are discharged into the atmosphere before any meteorite has traveled through even the upper half of the earth's air blanket; and any contention that visible meteors of ordinary nightly occurrence at an average distance of 100 miles from the observer may be occasioned by minute particles, and yet survive to register a visible course 15 to 30 miles in length is, in the judgment of

the writer, entirely untenable.

That the train of the meteor of March 24 persisted and in its later appearance did not show any light phenomena foreign to ordinary clouds, is considered by the writer as evidence that it was composed of finely divided meteorite dust mixed with such gases as resulted from its aerial conflict, and had been dispersed by the powerful out-rushing air-blasts in all directions from the front and sides of the meteorite. The surface markings on all freshly fallen meteorites indicate that during flight they are subjected to conditions comparable to the holding of an icicle in the blast from an acetylene welding torch, namely, a very rapid liquifaction, volatilization, and dispersion at the surface while the interior remains unchanged. The behavior of the cloud, as described by witnesses and as recorded in the photographs, was what would be expected in a cloud of various-sized dust particles, namely, a noticeable sinking and a gradual thinning, the while drifting with the wind, as would an ordinary vapour cloud. It would be interesting to know what weight of material was represented by the large cloud here described.

No definite conclusion has been reached as to the exact length of time the cloud remained visible, but we may be certain that it was visible for at least 90 minutes. Some witnesses assert that traces of it were still visible three hours after its formation. The drawing by Martinez shows quite a heavy cloud 51 minutes after the meteor's passage. Dr. Strong records its visibility at 6:15 and we know that he and the cloud had been, during this interval, moving away from each other until at that moment they were approximately 350 miles apart. The cloud could not have been very small to be visible at that distance.

The Plotted Course

I shall not encumber this account with all of the various testimonies from the many witnesses but shall merely point out the important facts which these interviews (a hundred or more) established.

Those who witnessed the meteor from points between Melrose and Ft. Sumner, New Mexico, saw it moving in an apparently horizontal, or nearly horizontal, course from east to west, only a few degrees above the horizon. From Tucumcari and neighboring points it was viewed in the same general direction and showed a slight declination to the westward, but was seen at an apparent elevation of about double that witnessed from points 50 miles farther south.

Those who viewed the display from Raton, New Mexico, and from Trinidad and Timpas, Colorado, looked southeastward and saw it about the same apparent altitude and traveling in an apparently almost horizontal course comparable to the view had by those at Tucumcari, except that they viewed it from the opposite direction.

For those who were interviewed in Stratford, Texas, Texhoma, Oklahoma, Texline, and Clayton, New Mexico, the meteor passed almost over head, and its course seemed to lie in an almost vertical plane whence it

vanished about 12° S. of W.

To the people who were fortunate enough to see the fireball from Wagon Mound, New Mexico, it appeared to rise out of the horizon from a point 12° north of east and when it had reached an altitude of about 20° to 30° (estimate) it vanished.

These reports made it very easy to arrive at a fair understanding of its general course; but when it came to a matter of definitely plotting

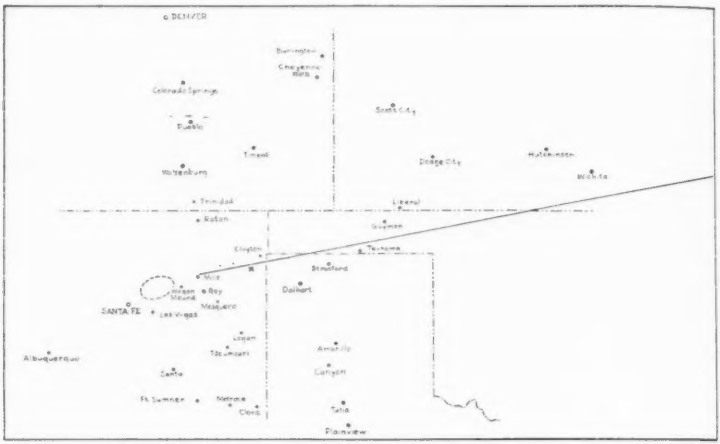
FIGURE 4.

Luminous train as it appeared about 2 min. after meteor's passage, from a point 22 miles north of Dalhart, Texas. Photographer Bert D. Latham.

it the case was more difficult. Disagreements among even the best observers as to the exact location and direction persisted in spite of all efforts to harmonize them. A few days later, when Dr. Strong's report had been received stating that "it wobbled in its course" matters began to clear up and when finally the photographs by Brown and Latham arrived, the warped train of the meteor was definitely established.

From the start, some few persons who happened to see the meteor from its very earliest appearance had insisted that it changed its course.

While at first this seemed improbable we now know that such was the case. Near the beginning of its visible course it is shown in the photograph, Figure 4, and the drawing by Martinez, to have borne strongly to the southward and then turned toward the west, following subsequently a zigzag course over a line which bears about 12½° southward from a due east-west line. (See map.)



Map showing the general course of the meteor of March 24, 1933, and the principal towns where interviews were held with witnesses to its flight. X shows location from which Mr. Brown's photograph was made. Midway between Mills and Clayton meteorite fragments have been found.

The terminus of the visible course seems to have been a few miles northeast of Mills, New Mexico, as determined by numerous interviews which were plotted in surrounding points and from impressions received in interviews in the immediate vicinity. There is, however, strong evidence of the extension of this visibility for those near enough to see its reduced luminescence. Unfortunately, no very definite conclusion could be reached from this point westward.

We may be fairly certain that the vanishing point was about 17 miles above the location designated and we may be sure that the angle of descent was not far from 8½°. This angle was determined as 7° to 9° by the use of an altitudometer on the best observers, and by using the sound period as recorded by observers near Stratford, Texas. The photographs which later arrived, however, establish it at 8½° with the horizontal at the point of disappearance.

Drifting of the Cloud

A number of people commented on the movements of the cloud after the meteor had disappeared. Several who were near the line of flight

reported a whirling motion of "the vapour." This motion is what would be expected in the wake of any rapidly moving and rotating object; but a much more significant movement in the cloud was its rapid drift to the eastward or slightly northeast. Because of the very great distances from which it was viewed, its apparent motion was slow and did not impress the majority of those who saw it; but in reality its motion must have been very rapid as described by those who took account of it.

FIGURE 5.

Luminous cloud as it appeared about 5:30 A.M. from Albuquerque, New Mexico. Distance from photographer about 240 miles. Lens 6½-inch focus. Photographer H. A. Brooks.

Mr. Brooks emphasized the difficulty which he had in getting his camera set up in time for the picture because the cloud looked as if it were going to sink behind the Sandia Mountains before he could complete his arrangement. It should be noted that from Albuquerque, Mr. Brooks was looking at the cloud almost end on and from a distance of 156 miles from its terminus. But according to Mr. Reynolds of the same city, who saw the meteor almost throughout its entire flight, it disappeared behind the mountains before it was extinguished, and this would mean that the cloud, seen and photographed by Mr. Brooks, was in reality still farther away, since it was produced previous to the terminal point. Also, the cloud had been drifting, or as it appeared from Albuquerque, sinking during 27 minutes before the picture was taken. Mr. Brooks estimated that it "sank" through a distance equal to the vertical thickness of the cloud as shown in his photograph during the 7 or 8 minutes he was setting up the camera.

Observers at Trinidad indicated to me the apparent rate of motion, a few nights later, in cumulus clouds which were drifting past the moon. The motion indicated was one degree in 12 seconds or 5 degrees per minute. However, the exact direction of the cloud when photographed

from Trinidad, Colorado, proves that it had drifted about 45° previous to the making of the exposure, which, judging from the light in the sky, must have been about 30 minutes after the meteor's flight. By measurement on this photograph,* using landmarks plainly shown in the picture and comparing the locations thus established with that of the terminal cloud as previously determined by our survey, we find that the cloud had drifted 82 miles in approximately 30 minutes. Mr. West, 60 miles to the northeast, also photographed the cloud, recording the time of his photograph and the direction in which the camera was pointing. It is probably safe to conclude that the cloud drifted at a rate of about 165 miles per hour. The fact that its direction of drift was almost exactly the reverse of its previous flight may or may not be significant.

Detonations

The detonations produced by this meteor were described in the usual manner, as like thunder, an aëroplane in trouble, the back-firing of a tractor. The only difference noted by the writer was the fact that these sounds were heard to greater distances from its line of flight than is usual. In some cases more than a hundred miles. Like all other meteors which have been studied by the writer, the sounds were less noticeable near the end of the flight than on each side of the latter part of its visible course, a phenomenon which has been nicely explained by Pickering in connection with the great meteor procession of February, 1913.[2]

The whizzing or whining noise as of flying projectiles subsequent to the meteor's disappearance was not reported in connection with the meteor of March 24, 1933, save in a few instances and these were too indefinite to be given much weight. But this may be due to the fact that their flight was over almost entirely uninhabited territory after they had reached a level that should have rendered their passage audible. However, after examining fragments of the metorite the writer is led to doubt the survival of any large mass much beyond the vanishing point of the fireball.

A widely circulated report that windows were broken in Texline, Texas, by the percussion proved upon investigation to be incorrect.

As with all of the meteors which the writer has investigated, there were many people who in this instance reported hearing a swishing or whining noise at the instant of the fireball's passage. Of course it is at once evident that a sound from the meteor passing 50 or 100 miles from an observer would require minutes to reach him, yet one meets with this same story so frequently as to raise the question whether there may not be a method of sound transmission at the velocity of ether waves. Dr. E. H. Sellards has called attention to this same problem in his description of the great meteor of June, 1923.[3] The explanation usually offered is the psychological one that observers unconsciously associate the meteor with the passage of an ordinary rocket and that their

*A photograph which could not be secured for publication.

memory of the event also associates the sound of the rocket's passage, assigning it as an accompaniment of the meteor's flight. However, reports of sound simultaneous with the passage of the meteors come so frequently and in many cases under circumstances which seem to justify serious consideration of the problem. In several instances witnesses have testified emphatically regarding various meteors, that such a swishing noise first drew their attention and led them to seek its source when as yet buildings or other objects hid the meteor from view. One, of course, feels that the unexpected lighting of the landscape may have been the real stimulus which aroused them and that confused recollections led them later to assign as the cause the sounds which really arrived later. However, to assign such an explanation in many instances which have come under my personal notice seems rather presumptuous.

While the present paper has been in preparation the writer was given the following account by Mr. J. H. Bruer of Crawford, Nebraska, who witnessed the daylight fall of August 8, 1933, at 10:20 A.M.

Mr. Bruer is an implement dealer whose building faces the south and the door which is about 10 feet square was standing open that morning. He was talking to a customer, while uncrating some implements, about 22 feet (measured by the writer) back from the open door when he heard what he supposed was the "banking of an aëroplane." Being somewhat interested in aëronautics he said to the customer, "I wonder who that fellow is," and started walking toward the door. (I had him repeat this action while holding a watch on him and concluded it was about three seconds from the hearing of the first sound until he reached a point where he could see the meteor.) When he reached a point near the door he expressed his surprise and called the customer to come and see; for he beheld a huge fireball moving across the sky. It was almost due south when first seen and our survey, later completed, proved that it was about 100 miles away, moving from S.S.E. to N.N.W. It vanished about 20 miles S.W. from where Bruer was standing.

After standing for perhaps a minute looking at the cloud left by the meteor and commenting upon the strange event they walked back and he resumed his work, whereupon they were again startled by a rumbling sound which resembled that made by the passing of a huge army truck with solid rubber tires (such a truck from the nearby fort passed in front of his building daily).

Mr. Bruer is a man of intelligence and one who is not at all excitable and it can hardly be doubted that he actually heard two different sounds as above described. That both came from the meteor cannot be proved but all inquiry failed to reveal that any aircraft was afloat at that hour in the vicinity of Crawford or to bring forward any other explanation of the strange sound. Several widely scattered observers reported the hearing of similar sounds at the moment of passage while others failed to record any sound whatever. The above is one of many such instances which have led the writer to believe that there may be, in connection with meteors, ethereal as well as aerial propagation of sound.

Without exception, those who have reported this peculiar phenomenon describe the sound as a sort of hum, whine, or a swishing noise, occasionally comparing it with the noise produced by thrusting hot iron into cold water. Seldom has there been indicated any resemblance to the detonations which arrived later. This distinctive character of the sound would argue against the idea of confused recollections above mentioned. I prefer to leave the matter as an open question as to whether there may be propagation of sound by more rapid means than that with which we are acquainted.

Velocity

Attempts were made to ascertain the velocity of the meteor by various methods. Several persons who witnessed the greater part of its entire flight from points a hundred miles or more on either side of its course were asked to indicate its rate of travel by motion of the pointing finger while being timed. Others who were indoors when it first appeared and walked or ran out, in order better to see the finish, went through the same motions again while being timed by the watch. The estimate of the meteor's duration thus arrived at varied from 12 to 23 seconds, with an average of 16.6 seconds. The visible course of the meteor extended approximately 440 miles but it is estimated that the average extent of the path for those used in the velocity determination was 335 miles, which would give the meteor an average velocity of slightly more than 20 miles per second.

Dr. Strong[4] estimated that the meteor was visible from his location at Springer, New Mexico, for only about 5 seconds, and this estimate was checked by the railroad conductor and must be given considerable weight. It happens, however, that the location of Dr. Strong's train was such that a hill cut off about 5° from the normal horizon. This, together with the earth's curvature, doubtless prevented his seeing it during its earliest visibility. Another factor which must have shortened his period of visibility was the fact that he was located some miles west of the vanishing point which might require that it travel some distance after developing luminosity before becoming visible from a point beyond its terminus. Mr. Norton, who was about 150 miles farther east first saw the meteor low in the northeast appearing as a flickering star somewhat brighter than Venus at her best. It is quite certain that in this condition it would not have been visible a hundred miles farther away. I think we may assume that Dr. Strong's description refers only to the latter part of the display.

It is probable that the first impact with the atmosphere took place at a relative velocity of about 40 miles per second which would be consistent with the calculated velocity of meteorites in space at 26.16 miles per second, if we allow for the almost opposite direction of the earth as would be the case at this hour of the day.

Height

The height of the meteor's course was determined by means of altitude measurements as given by those on each side of its trajectory who were in position to best recall what they had seen. In several instances buildings were in the foreground which made the records quite dependable. A second method was that of measuring on the photographs taken and leveling up with the horizon from the spot on which the camera was set. A third method was by having observers who were directly under its course go through the same motions which they remembered having gone through between the seeing of the fireball and the arrival of the detonations.

Of these methods certainly the most dependable was that of measuring photographs after having visited the spots from which the photographs were made and carefully recording the angles for the boundaries of the picture. Here our only source of error came in the movements of the cloud which may have taken place after its formation. Unfortunately, no photograph showed the end point as they were taken some time after the flight (except the Brown photograph) and the end point had probably faded out.

Mr. Chas. Brown remembered that the clock on the shelf behind him was striking five just as he was approaching the breakfast table when the light first appeared. Later when the sound arrived he noticed the time and found it was 3 minutes after five. The position of the clock hands with reference to striking was checked by the writer and this would not allow for an error of more than 15 seconds. This reading then should be 2 min. 45 sec.

At Stratford, Texas, two men were timed while re-enacting their experiences of the morning the meteor passed and they gave 2 min. 30 sec. as the time for the sound to reach them. In their case, however, their activities were such as to make this estimate of only average value.

The height at first appearance of the meteor can be fairly relied upon as it was seen by several persons slightly above buildings and these altitudes were measured by instruments on the spot from which it was seen —in two cases through windows by observers seated at desks. The height was thus determined as 78 miles above a point not far from Howard, Kansas. The height at the finish was less certain. It was surely not less than 12 miles and may have been as much as 18 miles above the surface.* Our best measurement of height is the one based on Mr. Brown's notation of 2¾ minutes for the sound to reach him at the point marked X on the map. If we allow an average velocity of 800 feet per second for sound to reach him from the rarefied atmosphere in which it arose, we conclude that the nearest point to him was 26 miles.

*Just before going to press with the report an interview was had with Mr. E. H. Wolf of Pueblo, Colorado, who watched the meteor from his window just over the top of a school building across the street. Bearings taken from the window by means of an instrument establish the height of the end point as 17 miles.

Unfortunately, the velocity of sound at this level is problematical.

The Point of Landing

Due to the very erratic course which the projectile was traveling during its visibility the location of the fall is a very difficult matter to determine. The course is indicated on the accompanying map and the angle of descent was approximately 8.5 degrees with the horizontal at the vanishing point. If we allow that the course subsequent to the time when the light was extinguished ended midway between the vertical and the point where the projected visible path would meet the earth, and assume a height of 12½ miles for the vanishing point, then the landing should have taken place somewhere about 20 miles west and 5 miles south of Wagon Mound, New Mexico, and either north or south of this point, depending on the deviations from a regular course. As a matter of fact it has been impossible to determine satisfactorily the height at which the light disappeared, which may have been as much as 18 miles. This renders the location of the fall quite questionable. Practically all of the country west of Wagon Mound is sparsely settled and much of it is very rough, hence the finding of the fall will be very difficult.*

Just before going to press a trip along the line of flight some 35 miles back from its point of disappearance resulted in the recovery of a few fragments from this great fireball, one of which had been picked up immediately after its fall. The texture of the stone, which is very friable, renders it unlikely that any considerable mass landed intact.

The location of these fragments proves that our survey had correctly located the path of flight.

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*Since establishing the height at which the fireball vanished as 17 miles, the location of the landing of the main mass (if such a mass landed) should be considerably farther west.

The Japanese Eclipse Expedition of 1934

By JOSEF J. JOHNSON

Total eclipses of the sun have a habit of occurring in out-of-the-way places. Also, since oceans cover some three-fourths of the earth's surface, it is not unusual for the path of totality to lie almost entirely over water, crossing only a few scattered islands. The islands of Losap and Oroluk in the eastern Carolines, the only favorably located points of observation for the eclipse of February 13-14, 1934, can perhaps boast of being peculiarly inaccessible by the ordinary means of transportation. It was an act of particular graciousness, therefore, for the National Research Council of Japan to invite astronomers from all over the world to participate in the expedition which was to be conveyed to Losap by the cruiser "Kasuga" of the Imperial Japanese Navy. Circumstances unfortunately prevented many observers from accepting. Several had signified their hopes or intentions of coming, but when the "Kasuga" finally steamed out of Yokohama harbor on the afternoon of January 15, only two foreigners were aboard, Dr. Willi M. Cohn, of the University of California, and myself.

Meanwhile every possible arrangement had been made for our comfort and convenience. Commander Akiyosi, of the Naval Hydrographic Office, had seen to the purchasing of supplies and had engaged the services of a cook skilled in the preparation of western-style dishes. Professor Hirayama, secretary of the Council, acted as our guide during the few days preceding the departure and arranged an excursion to the new Tokyo Observatory, where we had the pleasure of meeting the director, Dr. Kiyofusa Sotome, who was also to be the leader of the expedition.

The eight-day voyage to Losap was delightful except for one very rough night, about which the less said the better. Daily exhibitions of *sumo* and *judo* (Japanese-style wrestling) by the sailors provided a form of entertainment quite unusual on eclipse trips.

The passage through the reef into the Losap lagoon was too shallow to be negotiated by the "Kasuga." While the apparatus and supplies were being transferred to small boats and landed, most of the party engaged in a sightseeing tour of Losap and the neighboring island of Laol. Both islands are densely covered with tropical vegetation. It was quite necessary to wear our pith helmets, not to shield us from the sun but as a protection against falling cocoanuts. We made the pleasant discovery that the camp had already been prepared by the local administrative officials and that we were to be comfortably housed in the Catholic mission.

The two islands together comprise an area of only a square mile or so, yet they support a population of some 200 Micronesian "Kanakas." Another 200 inhabit the Pis Islands at the south end of the Losap lagoon, while there are 375 more on nearby Nama Island. All have an easy life,

eating cocoanuts, spearing fish, and paddling about in dugout canoes. They are a friendly and hospitable people and did their best to make our stay in their territory an enjoyable one.

During the three weeks preceding the eclipse most of the observers were very busy erecting and testing their elaborate apparatus. As I had only a small portable outfit, I had plenty of time to enjoy the tropical luxuriance of my surroundings and to slap mosquitoes. Swimming was good, with the temperature of the water about 80° F. The encircling coral reef afforded protection in more ways than one, as a native assured me that "shark-fish no come here."

The largest party of the expedition, that from Tokyo Observatory, set up its equipment on the south shore of Losap Island, not far from our living quarters, and prepared to carry out practically all of the various kinds of observations which are usually made of an eclipse of the sun. Dr. Sotome's particular work was the measurement of the Einstein effect, the displacement of star-images due to the bending of light-rays that pass close to the sun. This eclipse was particularly favorable because the sun happened to be in the midst of an unusually rich field of stars. Professor Tanaka and Mr. Koana, from the physics department of Tokyo Imperial University, recorded photographically the polarization and intensity distribution of the corona. Mr. Nakano made precise determinations of latitude and longitude, and, during the eclipse, secured a long-exposure photograph of the outer corona. Mr. Kubokawa also made a number of photographs showing the details of coronal structure. Mr. Fujita and Mr. Hattori conducted the spectroscopic part of the program. This is of course one of the most important items in the work of any eclipse expedition. There is the so-called "flash spectrum," that of the last disappearing edge of the sun or the first reappearing edge, and then there is the spectrum of the corona itself, a spectrum of bright lines not all of which have been identified as belonging to known elements. Hence we invent the name of a hypothetical element, "coronium," to conceal our ignorance. Just before I left America there appeared in the papers a note to the effect that Dr. Menzel and his collaborators at Harvard were hot on the trail of this mysterious "coronium." Perhaps these Japanese spectrograms will help, if the final identification has not already been made. Mr. Fukumi completed Tokyo's program by observing contact times; that is, the precise times of the beginning and ending of the various phases of the eclipse.

It had originally been planned to divide the Tokyo party, sending some of the observers to Oroluk. It is of course desirable to have stations spread along the eclipse track at different points in order to increase the probability that some one station, at least, will be free from clouds during totality. But in view of the rigors of a twelve-hour voyage over the trade-wind swell in a small boat and of the difficulties of establishing a camp on an uninhabited island with no fresh water supply, the plan was abandoned.

A slight "spreading" was achieved, however, by stationing the other

parties of the expedition on Laol Island. A further guarantee against accidental failure arose from the fact that the party from Kyoto Imperial University carried out independently most of the items on the

FIGURE 1.
EINSTEIN TELESCOPE OF THE KYOTO PARTY.
DR. JOE UETA.

Tokyo program. Dr. Ueta secured the Einstein plates and large-scale photographs of the corona. Professor Araki observed contact times and other members of the party conducted the spectroscopic work.

Commander Akiyosi, of the Naval Hydrographic Office, was interested in examining any possible change in direction of the earth's magnetic field during the eclipse. His apparatus consisted, in principle at least, simply of a small mirror attached to the needle of a compass. A narrow beam of light was directed upon this mirror, from which it was reflected to sensitized paper slowly moving upon a revolving drum. Here is a mechanism well adapted to detect any slight change in the position of the compass needle. During the eclipse the needle rotated slightly, the north end coming to the east by about one minute of arc, then going back at the end of totality. It seems strange that an eclipse should affect the compass, but such was actually the case. Two physicists from the Shanghai Science Institute were also interested in the earth's magnetic field; they measured changes of intensity rather than changes of direction. Lieutenant Commander Ito was the radio expert of the expedition. He investigated changes in the height of the Kennelly-Heaviside layer and in penetration frequencies.

FIGURE 2.
DR. WILLI M. COHN AND HIS MULTIPLE CORONAGRAPH.

Dr. Cohn's apparatus consisted of several cameras mounted on a polar axis, together with a visual polariscope operated by one of the Japanese from the Kyoto party, for measuring the polarization of the sky near the eclipsed sun. Dr. Cohn obtained a number of photographs through filters of different colors for studying the intensity distributions in the corona of light of different wave-lengths, also some plates for a photographic study of coronal polarization.

My own work consisted in measuring visually, that is to say directly, without photography, the polarization of the corona. A 4-inch equatorially-mounted refractor belonging to the California Institute of Technology had been fitted with a modified Lyot-type polarimeter in place of

the usual eyepiece. The program was to measure, at five different distances from the edge of the sun, the percentage of polarized light in the total amount of light received.

FIGURE 3.
FOUR-INCH TELESCOPE WITH POLARISCOPE ATTACHED.
JOSEF J. JOHNSON.

The many cloudy and rainy days during the three weeks preceding the eclipse were viewed with due alarm. Either the island was experiencing very "unusual weather" or the advertised estimate of a fifty-fifty chance of a clear sky was an optimistic overstatement. All fears were allayed, however, on the morning of the fourteenth. It was our good fortune to observe one of nature's rarest treats, a total eclipse of the sun under absolutely perfect conditions: clear blue sky for miles around, not the slightest suggestion of haze or mist, a steady atmosphere,—in short the kind of eclipse which the astronomer dreams about but seldom sees.

All the observing stations were near the shore of the lagoon, necessarily so in order to provide an unobstructed view of the sky and to be out of range of the falling cocoanuts. This location, coupled with the circumstance that the receding tide had left exposed a wide expanse of white coral sand, gave us an excellent opportunity to observe the shadow bands. They were remarkably clear and distinct and persisted for many seconds.

As the entire period of totality, 2 minutes and 4 seconds, was required for my polarization measurements, I did not get a good view of the corona as a whole. Other observers reported it to be of the "minimum" type; that is, the type associated with a minimum of sunspots and having long equatorial streamers. In the region which I was observing, just off the eastern edge of the sun, there was a conspicuous prominence shaped like an army tent, as viewed from one end. Prominences take all sorts of peculiar forms; thus in October, 1930, we had the "strawberry eclipse." In 1918 there was the famous "eagle prominence," and so on. From that one prominence, perhaps this should be known as the "army tent eclipse," though it may well be that some of the other prominences, which I did not see, better deserve to be remembered.

All the observers carried through their programs successfully and many excellent plates were secured. Unfortunately many months of careful measurement and lengthy computation must elapse before results can be made known. Some good photographs of the eclipse were taken by the newspapermen who accompanied the expedition, also a movie by the news-reel cameraman.

The natives of Losap took the eclipse very calmly and quietly. Such is not always the case. It was quite different at Alor Star, in British Malaya, at the eclipse of May 9, 1929. There the natives, Malays and Chinese, made a dreadful racket, yelling, beating drums, tin pans and wash tubs, and shooting off firecrackers. They had a legend that an eclipse is caused by a dragon swallowing the sun. The purpose of all this noise was to frighten the dragon and make him disgorge his meal. After a few minutes the sun came out again, thereby proving, of course, that the theory was correct and the remedy effective. Here at Losap, the natives had no tradition about eclipses. The Japanese had explained everything in advance: how an eclipse was a perfectly natural phenomenon, that the time of its occurrence could be calculated to within a few seconds, and that there was nothing of which to be afraid. The scheme worked beautifully,—one of the many instances of Japanese efficiency and of the confidence which the natives of the Japanese South Sea Territory have in their guardians.

The hospitality and generosity which the Japanese had shown in inviting foreigners to participate in the expedition did not end when the "Kasuga" landed us safely at the Yokosuka Naval Station. Perhaps the most memorable event of all was the dinner given on March 6 by the National Research Council of Japan, at which I had the pleasure of meeting the Council's president, Dr. J. Sakurai, and many of the other leaders who are so ably carrying forward in Japan the advancement of science in all its branches. I am tempted also to tell about a most delightful dinner as a guest of Professor Araki, after which we were entertained by beautiful *geisha* musicians and dancers, but that would carry us too far afield from things astronomical.

Changes of Period of Cluster Type Variables*

By SERGEI I. GAPOSCHKIN

The most recent development in the study of variable stars is concerned with the question of changes of period. Among the three types of definitely periodic variables, eclipsing stars, long period variables of the Mira type, and Cepheid variables (including the short period cluster type variables), only in the first group have we a definite dynamical reason for change of period (motion of the line of apsides). In the other two groups we may expect, without an exact knowledge of the mechanism of variation of period, many types of period change. But it is interesting to note that earlier conclusions and observations of rapid or sudden change of period have not survived subsequent criticism and further observations. In other words, the observed irregularities in the light curve are not caused by changes of period. For example, from the Harvard photographic material for the last forty years, it is not possible to confirm the secular or periodic changes of period previously suspected for the well-known cluster type variable SW Andromedae, although there are irregularities in the light curve. It appears that a constant period of $0^d.44227736$ is the best mean period for the interval from 1890 to 1933, based on over three thousand photographic observations. Similar conclusions are found to apply to S Arae and RR Ceti.

Today there is a definite belief that the most probable type of period change for cluster type variables is secular. In fact we find that secular changes of period have been derived for about forty cluster type variables. But it is important to note that the methods used for the determination of the changes of period are in many ways not satisfactory, and therefore many of the derived changes of period are illusory.

The characteristics and defects of the usual method can be studied in Müller's discussion of the periods of the cluster type variables in Messier 3. He derived maxima for three principal epochs: those given by Bailey for the interval 1895-1900; those given by Larink for 1921; and those given by Müller for 1925. This corresponds to intervals of about 7739 and 1530 days. The usual method is to find the difference (O — C) between the observed and predicted maxima. Müller derives two periods corresponding to the two above-mentioned time intervals, obtains the difference $P_1 - P_2$, and discusses these differences. He examined whether these differences represented changes of period. For this purpose he adopted as a criterion that the largest possible error in the determination of a maximum was $\pm 0^h.24$, thus obtaining for the errors of periods for the two intervals $\pm 0^d.0000013$ and $\pm 0^d.0000065$

*Concerning Müller's discussion of the variable stars in Messier 3, Veröff. d. Universitätssternw. Berlin-Babelsberg, 11, Heft 1, 1933.

respectively. In this manner he found that 91 out of 167 variables in Messier 3 had changing periods, and that two-thirds of these had decreasing periods. But he himself did not believe that so many of the stars had variable periods, and according to his conclusions, only about fifteen of them had "real" changes of period.

Three important points must be recalled. First, the estimated error in the determination of maximum is too small; it must be at least $\pm 0^h.5$. In this case, only two stars would survive his criterion for change of period. Secondly, the number of epochs (or cycles of the light change) are different in the two time intervals,* and so the weights of the corresponding periods are not equal. The period derived from the first interval has an uncertainty in the fifth or sixth decimal place ($\pm 0^d.000025$) the second, in the fourth or fifth decimal place ($\pm 0^d.0002$) and the two periods cannot be compared without bearing this fact in mind. For example Müller's star 111 has the largest change of period derived by him; the two periods are $0^d.5126376$ and $0^d.5125744$, and the period of Bailey, which forms the basis for the discussion, is $0^d.51265$. From these three periods it appears that the change of period is more evident for the second time interval, only because the weights of the two determinations differ. Thirdly, the use only of two time intervals, and the consequent comparison only of two periods, is very unsatisfactory. It is natural that if we determine two periods they will always differ slightly, producing an apparent increase or decrease of period. In order to demonstrate a change of period we need at least five such intervals over a period of from thirty to thirty-five years, and probably such a distribution of observations would give a random distribution of periods.

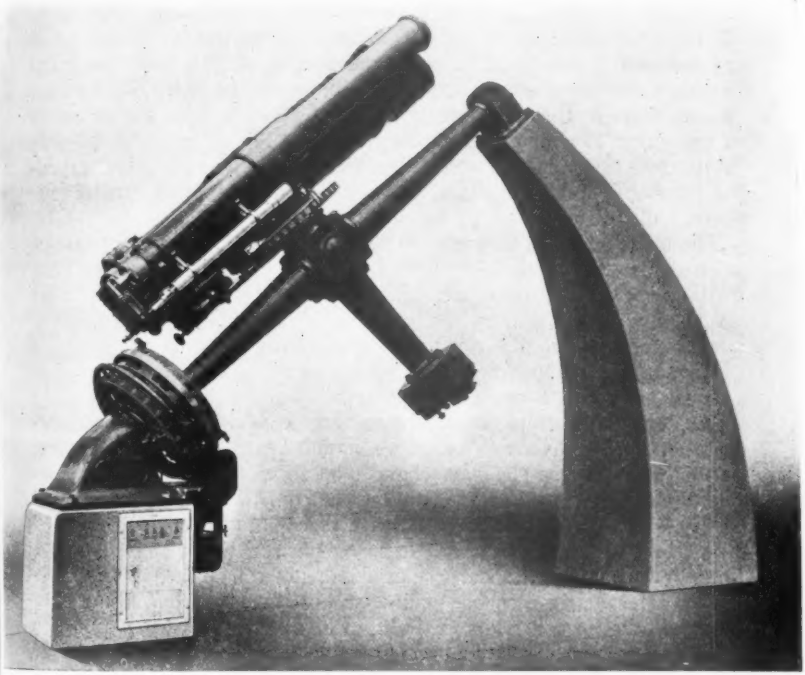
Further we must not forget that every periodical mechanism is subject to caprices, so that it is not always exactly periodic. It is of interest that the effects of this tendency and those mentioned above appear in Müller's conclusions. The frequency distribution of the stars with changing periods is the same as that of all the variables, so that every star seems to have the same chance of having a "variable period."

Finally it is interesting that Müller's decrease of the period is about twenty times larger than we might expect from our present opinion about the galactic cluster type stars. But possibly the conditions in the cluster make the life of a variable star twenty times shorter there.

*In addition, the exact number of epochs intervening in a given time interval was very difficult to determine.

A New Telescope for the U. S. Naval Observatory

A telescope, intended principally for photographing heavenly bodies never seen, has been completed by the Warner & Swasey Company, Cleveland, builders of machine tools and astronomical instruments. It is to be used at the U. S. Naval Observatory, and will be erected in Washington immediately.



THE 15-INCH TELESCOPE JUST COMPLETED BY THE WARNER & SWASEY COMPANY, CLEVELAND, FOR THE U. S. NAVAL OBSERVATORY AT WASHINGTON.

The telescope is a consequence of a prediction made 28 years ago by the famous astronomer, Percival Lowell, that a hitherto unknown planet existed, and would later actually be discovered. Lowell based his statement upon astronomical calculations which disclosed that certain heavenly bodies deviated slightly from their theoretical courses. He inferred, therefore, that some invisible force was drawing them out of their usual paths, and that this force would prove to be a new planet.

A 13-inch photographic telescope was installed at the Lowell Observatory, Flagstaff, Arizona, to investigate the truth of Lowell's assertions. And, indeed, fifteen years after Lowell's predictions, the 13-inch telescope located the new planet, which was later named Pluto.

The Naval Observatory became interested in this type of research and ordered a 15-inch telescope, of the same type as the Flagstaff 13-inch, to continue the work of searching for new planets, and photographing new asteroids, planets, and comets. This is the telescope now being shipped by Warner & Swasey.

The telescope is of the refractor type, with an aperture of fifteen inches and a focal length of ninety inches. It has three lenses, with non-spherical curves, in order to cover a wide field of view. The lenses are arranged at the upper end of the telescope, and photographic plates are inserted at the focal plane at the bottom of the telescope. The curves of the lenses are accurate to a millionth of an inch. They do not deviate from mathematical requirements by so much as one-twentieth of the length of a single wave of light.

Attached to the main telescope is a secondary telescope, called a guiding telescope, and next to the guiding telescope is a still smaller telescope, called a finder.

The observer looks through the finder in order to train the telescope upon the portion of the sky which he desires to study. He then looks through the guiding telescope, which is more powerful, in order to set the main telescope in the exact position desired. He then proceeds to take photographs of this area by use of the main telescope.

When a single photograph of a section of the sky is taken, a small or very distant planet forms on the photographic plate a single image, like a star, and therefore might not be recognized as a planet. But if successive photographs are taken, say, a month apart, the relative position of the planet among the stars changes because of its motion in the interval. This is the way searching for planets is done. Successive photographs are taken, and the plates are then placed in a "comparator." The observer thus looks through the whole series of plates, two at a time. In the comparator, stars, being fixed, still appear as dots of light—but the asteroids, or a chance planet, having moved relative to the stars, appear in the form of a line of light, or "trail."

The telescope will also be used to study the chemical composition of the stars, by the use of photographic plates in connection with the spectroscope.

Planet Notes for July-August, 1934

By CLIFFORD E. SMITH

The *Sun* will be moving in a southeasterly direction from the central part of Gemini, across Cancer, to the central part of Leo (near Regulus). On July 5 at 1:00 P.M., C.S.T., the earth will be at aphelion. The distance of the earth from the sun at that time will be about 94.4 million miles. This distance will decrease about 0.7 million miles by the end of August. On August 10 there will be an annular eclipse of the sun. The path of this eclipse will pass over South Africa. The position of the sun on July 1, August 1, and August 31 will be, respectively: R.A. 6^h 37^m, Decl. $+23°$ 11′; R.A. 8^h 42^m, Decl. $+18°$ 16′; and R.A. 10^h 35^m, Decl. $+8°$ 59′.

The phenomena of the *Moon* will occur as follows:

Last Quarter	July	3	at	2 P.M.	C.S.T.
New Moon		11	"	11 A.M.	"
First Quarter		19	"	1 P.M.	"
Full Moon		26	"	6 A.M.	"
Last Quarter	Aug.	1	"	12 P.M.	"
New Moon		10	"	3 A.M.	"
First Quarter		17	"	11 P.M.	"
Full Moon		24	"	2 P.M.	"
Last Quarter		31	"	2 P.M.	"
Apogee	July	12	"	12 M.	"
"	Aug.	8	"	3 P.M.	"
Perigee	July	26	"	4 A.M.	"
"	Aug.	23	"	2 P.M.	"

On July 26 there will be a partial eclipse of the moon, and, at the time of greatest eclipse, about 0.7 of the moon's diameter will be covered. The beginning of this eclipse, according to the *American Ephemeris** "will be visible generally in the western part of North America, the western part of South America, the Pacific Ocean, the Antarctic Ocean, Australia, and the extreme eastern part of Asia; the ending will be visible generally in the extreme northwestern part of North America, the Pacific Ocean, the Antarctic Ocean, Australia, the Indian Ocean, and central and eastern Asia."

Mercury will have an apparent retrograde motion in Gemini until July 22, and, after that date, its apparent motion will be easterly across Cancer to eastern Leo. At the beginning of July its distance from the earth will be about 55 million miles. After July 9 this distance will increase to about 130 million miles at the end of August. The change in apparent diameter will be from about 11 to about 5 seconds of arc, respectively. At the beginning of July Mercury will set about an hour after the sun, but it will approach rapidly inferior conjunction which will occur on July 11 at 6:00 A.M., C.S.T. During the middle of this period it will be a morning star, rising about an hour before the sun. Greatest elongation west will occur on July 31 at 3:00 P.M., C.S.T. (19° 31′). Conjunction with the moon in July will occur on the same day as inferior conjunction, and conjunction with the moon in August will occur on August 8 at 1:00 P.M., C.S.T. (Mercury 1°0 S). The position of Mercury on July 1 and on August 1 will be, respectively: R.A. 7^h 40^m, Decl. $+18°$ 35′; and R.A. 7^h 20^m, Decl. $+20°$ 21′. Superior conjunction with the sun will occur on August 25 at 12:00 P.M., C.S.T.

Venus will be moving with an apparent easterly motion from western Taurus, across Gemini, to eastern Cancer. It will continue as a morning star rising about two hours before the sun. Its distance from the earth will increase from about

**American Ephemeris and Nautical Almanac*, p. 581, 1934.

115 million to about 145 million miles, and the apparent diameter will change from about 13 to about 11 seconds of arc. Conjunction with the moon will occur on July 8 at 11:00 A.M., C.S.T. (Venus 6°.0 S), and on August 7 at 3:00 P.M., C.S.T. (Venus 2°.2 S). On August 2 at 3:00 P.M., C.S.T., Venus will be in conjunction with Mars (Venus 1°.1 S).

Mars will be a morning object rising about two hours before the sun. Its apparent motion will be direct from central Taurus to the eastern part of Gemini. Mars, however, is still too near the sun in apparent position to be of interest as a telescopic object. Its distance from the earth will be about 220 million miles, and its apparent diameter will be about four seconds of arc. Conjunction with the moon will occur on July 9 and on August 7 (Mars 3°.2 and 1°.5 S, respectively). A conjunction with Venus on August 2 has been mentioned under the notes on Venus.

Jupiter will be an evening object towards the south at sunset in Virgo. Quadrature east of the sun will occur on July 6 at 9:00 P.M., C.S.T. Conjunction with the moon will occur on July 18 at 9:00 P.M., and on August 15 at 10:00 A.M., C.S.T. (Jupiter 6°.7 N). The distance of Jupiter from the earth will increase from about 490 to about 570 million miles, and its apparent diameter will decrease from about 35 to about 30 seconds of arc.

Saturn will be in about the most favorable position for observation during this opposition since it will be at opposition on August 18 at 5:00 A.M., C.S.T. During this period Saturn will be toward the south at midnight in western Aquarius. Its distance from the earth will be about 830 million miles, and its apparent diameter will be about 17 seconds of arc. Conjunction with the moon will occur on July 27 at 9:00 P.M., C.S.T., and on August 24 at 5:00 A.M., C.S.T. (Saturn 3°.1 S).

Uranus will be a morning object in western Aries, and it will be towards the south at sunrise. Its distance from the earth will be about 1800 million miles, and its apparent diameter will be about 3½ seconds of arc. Quadrature west of the sun will occur on July 24 at 7:00 P.M., C.S.T. Conjunction with the moon will occur on July 5 at 7:00 A.M., C.S.T., August 1 at 2:00 P.M., C.S.T., and on August 28 at 10:00 P.M., C.S.T. (Uranus 6°.2 S). The position of Uranus on August 3 will be R.A. $1^h\,58^m$, Decl. $+11°\,28'$.

Neptune will be an evening object in Leo. At the beginning of this period it will set about four hours after the sun, but, by the end of August, its apparent position will be near that of the sun. Its distance from the earth will be about 2880 million miles, and its apparent diameter will be about 2.4 seconds of arc. The conjunction of the moon in July will occur on July 15 at 11:00 P.M., C.S.T. (Neptune 4°.0 N). The position of Neptune on July 2 will be R.A. $10^h\,48^m$, Decl. $+8°\,38'$.

OCCULTATION PREDICTIONS

(Taken from the *American Ephemeris.*)

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phe-

nomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′.

Date 1934		Star	Mag.	IMMERSION Greenwich C.T.	IMMERSION *a*	IMMERSION *b*	IMMERSION Angle E from N	EMERSION Greenwich C.T.	EMERSION *a*	EMERSION *b*	EMERSION Angle E from N
				h m	m	m	°	h m	m	m	°
July	20	87 Vir	5.8	2 35.3	..	..	177	3 3.0	..	..	225
	23	163 G.Oph	6.3	23 15.5	—1.4	+1.6	67	0 18.3	—1.1	+0.2	302
	24	χ Sgr	4.4	1 30.8	—2.0	+1.4	39	2 22.3	—1.9	—0.9	318
	25	σ Sgr	2.1	1 31.7	—1.6	+1.2	66	2 44.7	—1.8	+0.3	275
	26	329 B.Sgr	6.8	1 53.3	—1.4	+1.3	69	3 5.5	—1.6	+0.8	256
	26	336 B.Sgr	6.5	3 5.2	—1.6	+0.9	75	4 19.2	—1.6	+0.6	242
	27	θ Cap	4.2	3 33.4	—1.3	+1.5	45	4 43.3	—1.8	+0.6	260
	29	252 B.Aqr	5.8	2 5.6	—0.3	+1.5	84	3 0.9	—0.5	+1.9	219
	29	197 G.Aqr	6.3	3 13.4	—1.0	+1.1	108	3 54.2	—0.4	+2.5	189
Aug.	1	101 Psc	6.2	6 15.6	—1.2	+1.5	89	7 14.0	—0.4	+2.5	205
	2	26 Ari	6.2	8 14.7	—1.5	+1.5	77	9 29.0	—1.1	+2.1	223
	20	43 Oph	5.4	2 28.4	—1.6	—1.1	105	3 34.7	—0.7	—0.6	241
	22	274 B.Sgr	6.1	6 44.3	..	..	339	6 45.5	..	..	334
	29	47 B.Ari	6.5	5 59.5	—0.6	+2.4	36	7 8.6	—1.7	+0.9	260
	31	28 Tau	5.2	2 38.9	+0.2	+0.6	121	3 13.4	+0.8	+2.1	205
OCCULTATIONS VISIBLE IN LONGITUDE +91° 0′, LATITUDE +40° 0′.											
July	24	χ Sgt	4.4	0 50.9	—1.7	+1.6	63	1 53.4	—1.3	0.0	305
	24	10 G.Sgt	5.7	5 38.4	—2.5	—2.0	134	6 19.3	—0.2	+1.0	204
	25	σ Sgt	2.1	1 4.1	—1.0	+1.3	82	2 13.0	—1.3	+0.9	269
	26	329 B.Sgt	6.1	1 30.3	—0.8	+1.4	81	2 35.8	—1.2	+1.3	253
	26	336 B.Sgt	6.5	2 35.7	—1.2	+1.3	78	3 46.6	—1.5	+1.1	250
	27	θ Cap	4.2	3 7.4	—1.0	+1.9	43	4 9.8	—1.4	+0.9	272
	28	150 B.Aqr	6.0	11 17.7	—0.9	—0.6	73	12 16.5	—0.2	+0.3	220
	29	197 G.Aqr	6.3	3 0.8	—0.2	+1.0	108	3 40.7	—0.3	+2.4	197
Aug.	1	101 Psc	6.2	6 0.0	—0.2	+1.7	70	7 0.6	—0.4	+1.9	229
	2	26 Ari	6.2	7 54.1	—0.4	+2.1	53	9 3.0	—1.0	+1.6	248
	20	43 Oph	5.4	1 55.3	—2.0	—0.3	98	3 14.5	—1.7	—0.5	257
	29	47 B.Ari	6.5	5 51.3	+0.5	+3.1	7	6 32.0	—1.9	+0.4	293
OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′.											
July	7	16 Tau	5.4	11 21.7	—0.3	+1.3	87	12 20.8	—0.1	+2.0	229
	7	q Tau	4.3	11 38.6	0.0	+1.9	57	12 42.1	—0.7	+1.4	259
	7	20 Tau	4.1	11 52.0	—0.6	+1.3	90	12 52.9	—0.2	+2.2	225
	7	21 Tau	5.8	12 1.6	0.0	+2.1	51	13 6.6	—1.0	+1.3	263
	23	134 B.Sco	6.4	1 34.9	—1.7	+1.5	53	2 37.3	—1.0	—0.4	316
	24	10 G.Sgr	5.7	4 38.7	—1.9	—0.4	126	5 41.0	—2.0	+1.0	228
	25	ϕ Sgr	4.8	10 38.3	—1.5	—1.8	113	11 20.8	+0.4	+1.0	202
	28	150 B.Aqr	6.0	10 44.9	—1.0	+1.2	35	11 53.9	—1.5	0.0	248
Aug.	2	26 Ari	6.2	7 49.8	+0.6	+2.2	23	8 32.8	—0.6	+0.8	286
	4	χ Tau	5.3	10 18.7	..	..	137	10 44.9	..	..	187
	20	43 Oph	5.4	1 3.7	—1.2	+0.1	122	2 15.5	—2.1	+0.9	253
	26	λ Psc	4.6	12 26.8	—1.3	—0.8	83	13 26.3	—0.5	+1.0	211

Variable Stars

Monthly Report of the American Association of Variable Star Observers for April, 1934

We welcome an initial report from Miss Dorothy N. Davis of Mills College, California. Mr. L. C. Peltier is back at Delphos, Ohio, after an auto trip of five months duration through the southern and western states. Mr. Peltier's variable

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1934.

Feb. 0 = J.D. 2427469; March 0 = J.D. 2427497; April 0 = J.D. 2427528.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
S SCL	W SCL	W CAS	X CAS	R ARI	S PER
001032	*002833*	004958	014958	021024	021558
471 10.5 En	485 13.0 En	516 9.0 Jo	500 10.7 Bn	516 10.4 Jo	510 10.0 So
485 11.6 En	Y CEP	517 9.6 Sh	504 10.7 Bn	517 9.9 Wd	510 10.2 Hf
486 11.3 En	003179	517 9.6 Wd	510 11.0 So	522 10.7 Jo	511 10.3 Rb
X AND	516 10.4 Jo	517 9.9 So	514 11.5 Pt	W AND	512 9.9 Wd
001046	522 10.6 Jo	522 9.7 So	516 10.7 Jo	021143a	513 10.3 SR
471 11.8 Bm	532 10.7 Jo	522 9.2 Jo	517 11.0 So	510[12.7 B	513 10.5 Pk
481 10.4 Bm	536 11.0 Jo	526 9.5 Wd	518 11.0 Bn	T PER	513 10.2 Sz
482 9.9 Da	U CAS	530 9.7 So	522 11.0 So	021258	514 9.9 Pt
488 10.0 Bm	004047a	530 9.8 Jo	524 11.2 Bn	477 9.2 Lt	514 9.7 So
510 9.0 GC	482 7.0 Da	533 9.2 Jo	530 11.2 So	483 9.3 Lt	517 9.9 Sh
512 8.5 GC	507 8.9 Pf	536 9.0 Jo	530 11.0 Jo	503 9.0 Lt	517 10.0 Wd
516 8.5 Jo	508 9.3 Kn	536 9.2 My	532 11.5 Jo	509 8.8 Sq	517 9.9 So
522 8.4 Jo	509 9.0 Hf	536 9.6 Hf	536 11.5 Jo	510 8.9 Hf	517 9.6 Jo
537 9.0 Jo	509 8.8 Sh	U TUC	U PER	512 9.4 Wd	522 10.1 So
T CAS	510 9.1 Hi	*005475*	015254	514 8.9 Pt	522 10.4 Rb
001755	514 9.2 Pt	473 8.6 Sl	501 10.1 Ry	517 9.2 Wd	526 10.0 Wd
501 11.1 Pk	516 9.4 Jo	482 8.5 Sl	507 10.0 Ry	517 8.8 Jo	528 10.3 Ra
506 11.5 Gg	517 9.8 Wd	485 9.2 En	509 10.1 Sh	526 9.4 Wd	528 9.4 Pk
510 10.8 Ra	517 9.7 Sh	491 8.6 Sl	509 10.0 Hf	528 9.0 Ra	530 10.3 So
512 10.9 Wd	517 9.8 Hi	496 8.6 Sl	510 9.9 So	532 9.0 Jo	531 10.2 SR
514 10.5 So	517 9.5 Kn	501 9.0 Bl	511 10.0 Kn	536 8.9 Jo	532 9.9 Jo
514 11.0 Pt	522 10.0 Kn	503 8.9 Ht	512 9.7 B	536 9.0 Hf	532 10.3 Me
516 10.6 My	522 9.8 Jo	512 9.3 Ht	513 10.0 Rc	537 9.3 Wd	533 10.2 SR
516 10.0 Jo	528 10.3 Ra	514 9.8 Bl	514 9.8 Pt	Z CEP	536 10.2 Hf
517 10.5 So	532 11.1 Jo	519 10.0 Ht	514 9.8 So	021281	536 10.3 Jo
517 10.7 Wd	RW AND	523 10.0 Bl	516 9.6 Jo	505[14.4 Br	537 10.1 Me
522 10.5 So	004132	Z CET	517 9.5 Kn	533[14.6 Da	537 10.1 Wd
522 10.7 Jo	500 13.7 L	*010102*	517 9.8 So	o CET	R CET
526 9.9 Wd	V AND	503[11.8 L	517 9.5 Hf	*021403*	*022000*
535 9.0 Mc	004435	U SCL	520 9.4 Ry	472 4.3 En	503 8.1 L
537 10.6 Jo	471 13.3 Bm	*010630*	522 9.5 So	476 4.3 En	510 8.2 Hi
R AND	481 12.0 Bm	501 12.0 Bl	522 9.0 Jo	479 4.1 Cy	518 8.0 Hi
001838	488 11.9 Bm	514 13.5 Bl	530 8.8 Jo	481 3.5 Si	RR PER
482 11.4 Da	500 11.1 L	U AND	530 9.3 Kn	482 4.2 Cy	022150
500 11.1 L	510 11.0 GC	010940	533 8.8 Jo	482 4.0 Da	510 13.5 So
S TUC	512 11.1 GC	500 12.2 L	535 9.2 Kn	483 3.6 Si	511 13.5 So
001862	RR AND	UZ AND	536 8.7 Jo	485 3.8 Si	513 13.4 Wp
471 10.4 En	004533	011041	536 8.9 Hf	485 3.6 En	513 13.2 Wa
482 10.5 Sl	481[14.8 Bm	500 14.5 L	537 8.9 Kn	502 4.4 Rb	525[13.2 Wa
485 10.7 En	500[13.9 L	S CAS	538 8.8 Rc	503 4.5 L	R FOR
501 10.8 Bl	RV CAS	011272	538 8.6 Jo	503 4.3 Cy	*022426*
503 11.1 Ht	004746a	447 11.4 Da	XX PER	505 4.9 Ah	501 11.0 Bl
512 12.5 Ht	507 14.0 Pf	478 12.3 Da	015654	509 4.7 Hf	514 10.7 Bl
514 12.7 Bl	— CAS	514[11.9 Pt	481 8.5 Lt	509 4.5 Rb	523 9.7 Bl
T SCL	004746b	R PSC	503 8.5 Lt	510 4.8 Cy	RR CEP
002438a	508 11.0 Pf	012502	UV PER	510 4.7 Ra	022980
471 11.0 En	W CAS	471 13.3 Bm	020356	511 4.6 Cy	518 11.0 Br
485 12.3 En	004958	481 14.0 Bm	505[13.9 Br	512 4.9 Hf	R TRI
T PHE	479 9.4 Da	488 13.8 Bm	508[13.7 Br	512 5.7 Se	023133
002546	509 9.8 Sh	RU AND	518[13.5 Br	514 5.2 Ah	511 9.6 Ah
485 13.0 En	509 9.9 Hf	013238	520[13.5 Br	516 4.6 Sx	512 9.8 Wd
501 11.1 Bl	510 9.5 Ra	500 10.5 L	542 12.8 Br	S PER	514 9.3 Pt
514 10.4 Bl	512 9.9 Wd	514 10.7 Pt	R ARI	021558	516 9.4 Jo
523 9.9 Bl	513 9.7 Ko	Y AND	021024	482 9.9 Cy	528 9.0 Ra
W SCL	514 9.9 Pt	013338	509 9.5 Hf	500 9.9 Pk	530 8.8 Wd
002833	514 9.7 So	500[13.9 L	510 9.8 So	504 10.3 Rb	532 8.8 Gv
471 13.1 En	516 9.3 My	514[11.5 Pt	514 10.0 Pt	509 9.5 Sq	533 8.5 Jo

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1934.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

T ARI
024217
513 8.6 Ko
516 8.4 Jo
522 8.2 Jo

W PER
024356
501 9.4 Ry
507 9.6 Ry
510 9.7 So
510 9.6 Hf
512 9.2 B
513 9.8 Jo
514 9.7 Pt
514 9.7 Ra
514 10.2 So
516 9.5 Jo
517 9.9 So
520 9.5 Ry
522 9.9 So
530 10.3 So
530 9.8 Jo
531 10.5 Sx
533 9.7 Jo
535 9.7 Mc
536 9.7 Hf

R HOR
025050
473 12.5 Sl
476 12.6 En
482 12.6 Sl
485 12.6 En
496 12.8 Sl
501 12.7 Bl
503 12.8 Ht
512 12.7 Ht
514 12.7 Bl
519 12.7 Ht
523 12.8 Bl

T HOR
025751
473 11.9 Sl
476 12.2 En
482 12.4 Sl
485 12.7 En
503 12.7 Ht
514 13.3 Bl

U ARI
030514
471 14.2 Bm
481 14.2 Bm
488 14.1 Bm

X CET
031401
503 10.2 L
516 9.5 Jo

Y PER
032043
500 8.9 Pk
509 8.7 Sq
510 9.5 Hf
513 9.1 Ko
513 8.7 Pk
514 8.9 Pt
516 8.9 Jo
522 8.7 Jo
528 9.3 Ra
528 8.4 Pk
530 8.8 Jo
533 8.7 Jo
536 9.0 Jo
536 9.0 Hf

R PER
032335
506 9.2 Kn
511 9.2 Kn
512 9.1 Hf
514 9.2 B
514 9.2 Pt
516 9.0 Jo
522 9.8 Jo
522 10.0 Kn
528 9.8 Ra
530 10.5 Jo
533 10.7 Jo
536 10.3 Kn
537 10.6 Kn

NOV PER
032443
510 13.5 GC
512 13.5 GC
513 13.6 GC
514 13.5 GC
530 13.2 GC

U CAM
033362
516 7.3 Jo
522 7.2 Jo
530 7.3 Jo
533 7.5 Jo
535 7.6 Jo
538 7.4 Jo

U ERI
034625
476 9.9 En
485 9.5 En

X PER
034930
481 6.5 Lt
502 6.5 Lt
513 6.4 Lt
522 6.5 Lt
532 6.5 Lt

T ERI
035124
476 8.6 En
485 9.0 En

T TAU
041619
471 10.3 Bm
481 10.3 Bm
483 10.4 Bm
488 10.2 Bm

R TAU
042209
471 10.7 Bm
481 9.4 Bm
488 8.8 Bm
500 8.1 L
501 8.9 Ar
506 8.9 Ar
506 8.8 Hi
508 8.9 Ar
509 8.9 Sh
509 8.9 Hf
510 8.7 Ra
514 8.5 B
514 8.9 Pt
515 8.9 Ar
516 9.2 Sx
516 8.6 Jo
517 9.1 Hi
522 9.0 Ar
522 8.8 Jo
528 9.3 Hi
530 9.2 Jo
530 9.4 B
535 9.8 Jo

W TAU
042215
500 10.8 L
510 10.6 So
510 10.3 B
514 10.6 So
514 9.9 Pt
516 10.0 My
516 10.3 Jo
519 10.2 B
522 10.6 So
522 10.5 Jo
530 10.2 Jo
533 10.2 Jo
535 10.6 Jo
535 10.8 So

S TAU
042309
481 14.8 Bm
501 13.9 Ar
508 13.9 Ar
515 14.0 Ar
530 12.0 B

T CAM
043065
478 10.8 Da
505 12.4 Da
529 12.1 Wd
543 13.7 Da

RX TAU
043208
500 10.9 L
504 10.8 Rb
510 10.4 B
511 10.6 Rb
516 10.4 Jo
517 10.3 Sf
519 10.2 B
522 10.2 Rb
529 10.4 Sf
530 10.4 Jo
533 10.5 Jo
535 10.6 Jo
536 10.2 Sf

R RET
043263
472 7.5 En
473 7.4 Sl
476 6.9 En
482 7.2 Sl
486 7.3 En
491 7.1 Sl
496 7.2 Sl
501 8.0 Bl
503 8.0 Ht
512 8.2 Ht
514 8.5 Bl
519 8.6 Ht
523 8.8 Bl

X CAM
043274
506 11.9 Kn
513 11.2 Kn
517 10.9 Kn
517 10.4 B
517 10.0 Jo
530 9.5 My
530 9.0 Jo
532 9.1 Pt
532 9.5 Me
533 9.1 Kn
533 8.8 Jo
535 9.2 Kn
536 9.3 Hf
536 8.7 Jo
536 9.3 My
537 9.1 Kn
538 8.8 Me

R DOR
043562
472 5.5 En
473 5.6 Sl
476 5.5 En
482 5.4 Sl
486 5.5 En
491 5.4 Sl
496 5.4 Sl
501 6.1 Bl
503 5.5 Ht

R DOR
043563
512 5.6 Ht
514 5.9 Bl
519 5.4 Ht
523 5.8 Bl

R CAE
043738
472 9.2 En
476 9.5 En
486 9.7 En
501 10.1 Bl
503 10.3 Ht
512 10.6 Ht
514 10.3 Bl
519 10.7 Ht
523 10.3 Bl

R PIC
044349
476 7.1 En
486 7.2 En
501 7.6 Bl
503 7.4 Ht
512 7.2 Ht
514 7.1 Bl
519 7.3 Ht
523 7.1 Bl

V TAU
044617
500 10.0 L
510 10.8 B
516 10.6 Jo
519 11.6 B
533 12.4 Jo

AB AUR
044930
478 6.9 Lt
484 6.9 Lt
500 7.0 Lt
513 6.9 Lt
522 6.9 Lt
532 6.9 Lt

R ORI
045307
479 9.5 Da
500 10.2 L
514 10.7 B
530 11.6 B

R LEP
045514
473 8.0 Sl
480 9.3 Oy
482 7.5 Sl
491 7.5 Sl
500 7.6 Pk
502 8.3 Pa
509 8.5 Pa
509 8.0 Sq
509 9.3 Sh
509 9.3 Hf

R LEP
045514
510 9.1 Rc
510 8.5 So
512 8.5 Pa
513 8.9 Ko
513 7.3 Pk
516 9.1 Sx
516 9.0 Rc
516 7.7 Jo
517 8.4 Pa
522 7.7 Jo
525 8.0 Ko
528 8.5 Ra
530 7.6 Jo
531 8.8 Rc
535 7.5 Jo
536 9.1 So

V ORI
050003
471 13.8 Bm
481 13.9 Bm
491 14.3 Bm
505 13.3 L
514 12.0 Ra
514 12.7 B
530 11.9 B
532 11.5 Pt

T LEP
050032
471 9.0 Bm
476 8.8 En
481 9.0 Bm
486 8.8 En
491 9.2 Bm
501 9.0 Bl
512 9.4 B
514 9.0 Bl
516 9.2 Jo
517 9.1 Wd
522 9.7 Jo
523 9.8 Bl
532 9.8 Pt

S PIC
050848
476 12.9 En
503 13.4 Ht
516 13.4 Bl
519 13.4 Ht

R AUR
050953
503 9.7 Wg
506 10.4 Ar
507 10.4 Ar
508 10.3 Ar
512 10.4 Hf
514 9.8 Ra
515 10.1 Ar
516 10.0 Ar
517 10.0 Jo

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1934.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R AUR	S AUR	T ORI	T ORI	S CAM	RU AUR
050953	052034	*053005a*	*053005a*	053068	053337
522 9.7 Jo	530 9.3 Jo	475 9.6 Cy	530 10.1 L	536 8.4 Jo	510[13.4 GC
522 10.0 Ar	532 10.0 Gy	477 10.5 Cy	530 10.1 Wd	536 8.7 My	532[12.0 Pt
527 9.6 Wp	532 9.2 Pt	479 9.8 Cy	531 9.7 SR	537 9.0 Kn	U AUR
527 9.6 Wa	533 9.5 Jo	482 9.7 Cy	532 10.0 Pt	RR TAU	053531
529 10.5 Wd	535 10.7 Kg	500 10.1 L	532 10.6 Jo	053326	505 14.3 L
530 10.1 Wp	535 11.0 Lr	501 9.4 Ar	532 10.1 Me	471 11.3 Bm	517 13.2 B
530 9.9 Wa	536 10.2 Hf	501 9.7 Bc	533 10.5 Jo	481 12.3 Bm	531 13.4 B
530 9.6 Jo	536 9.3 Jo	502 9.5 Ko	533 9.4 SR	482 12.5 Cy	SU TAU
532 10.5 Pt	540 9.3 Wa	504 9.6 Rb	534 10.4 Pt	499 12.5 Br	054319
533 9.6 Jo	W AUR	505 9.8 L	534 10.0 Me	502 11.9 Ko	479 10.2 Cy
536 9.2 Hf	052036	505 9.5 Ar	535 10.5 Me	504 11.5 Rb	482 10.2 Cy
536 9.5 Jo	500 9.8 Hi	506 9.4 Ar	535 11.0 B	505 11.8 Br	499 10.7 Br
537 10.3 Wd	505 9.1 L	507 9.5 Ar	535 10.6 Jo	505 12.0 L	501 10.0 Ar
538 9.2 Jo	506 9.4 Hi	507 9.6 Bc	535 10.4 So	506 11.9 Br	502 10.2 Ko
T PIC	509 9.0 Sh	508 9.3 Ar	535 10.5 Wd	507 12.0 Ry	504 10.0 Rb
052147	509 9.0 Hf	509 9.4 Ko	535 10.7 Pt	508 11.8 Br	505 10.7 Br
476 10.1 En	510 9.3 GC	509 9.6 Sh	536 10.7 Pt	510 11.6 Br	505 9.8 L
486 11.2 En	510 9.0 Hi	509 9.5 Hf	536 10.5 Jo	510 11.6 B	506 10.7 Br
501 11.9 Bl	512 9.2 GC	510 9.8 Hf	536 10.6 Me	511 11.8 Rb	506 10.0 Ar
503 12.5 Ht	513 9.0 GC	510 9.9 So	537 10.7 Jo	513 11.8 Wp	507 10.0 Ar
512 12.9 Ht	517 8.8 Hf	510 9.7 GC	537 10.8 Me	513 11.7 Wa	508 10.0 Ar
514 12.4 Bl	517 8.8 Hi	510 10.0 B	537 10.4 Wd	513 11.7 Ko	508 10.2 Br
T COL	517 8.3 Jo	510 9.9 Ra	538 10.5 Jo	513 11.8 SR	509 10.4 Hf
051533	522 8.3 Jo	511 9.6 Rb	538 10.7 Me	514 11.9 Wp	510 10.4 Hf
480 8.1 En	527 8.5 Wa	512 9.5 Ko	538 10.7 Pt	514 11.9 Wa	510 9.8 B
486 8.3 En	528 8.9 Hi	512 9.6 Wd	AN ORI	515 12.0 Ry	510 10.0 Br
502 7.9 Bl	529 8.9 Sf	512 9.7 GC	*053005t*	517 11.9 Wp	511 10.3 Ko
503 8.4 Ht	529 8.8 Wd	512 9.7 Hf	501 11.5 Ar	517 12.4 B	511 10.3 Rb
512 8.5 Ht	530 8.4 Jo	513 9.5 Ko	506 11.1 Ar	517 12.0 Wa	512 10.3 Ko
514 8.3 Bl	530 9.0 GC	513 9.7 SR	507 11.3 Ar	519 12.5 Br	512 10.0 Wd
519 8.5 Ht	530 8.7 B	513 9.5 Pt	508 11.3 Ar	520 12.4 Br	512 10.3 Hf
523 8.5 Bl	532 9.0 Pt	513 9.5 GC	512 11.7 Wd	525 12.0 Wp	513 10.2 Wa
S AUR	533 8.5 Jo	514 9.5 Ko	514 11.3 Ra	525 12.0 Wa	513 10.1 Wp
052034	536 8.6 Jo	514 9.5 Pt	515 11.4 Ar	527 11.4 Wa	513 10.1 Ko
500 8.8 Pk	536 9.0 Sf	514 9.9 So	516 11.4 Ar	527 11.2 Wp	513 9.9 Pt
505 8.9 L	536 8.8 Hf	515 9.7 Ar	517 11.7 Sh	528 11.6 B	513 10.3 SR
508 9.2 Sq	S ORI	516 9.4 Pt	517 11.7 Wd	528 11.3 Me	514 10.0 Ko
509 9.7 Sh	*052404*	516 9.9 My	521 11.5 Ar	529 11.4 Wp	514 10.2 Pt
509 9.8 Hf	500 10.6 L	516 9.6 Sx	522 11.4 Ar	530 11.5 Wp	514 10.3 Wp
510 10.6 So	504 10.5 Rb	516 9.4 Ar	530 11.6 Wd	530 11.3 L	514 10.2 Wa
513 10.0 Ko	509 10.8 Pa	516 10.0 Jo	S CAM	530 11.7 Wa	515 10.0 Ar
513 9.1 Pk	510 10.6 So	517 9.9 Jo	053068	531 11.6 Wa	515 10.0 Mw
514 9.6 Kg	510 10.0 B	517 10.2 B	506 9.8 Kn	531 11.7 Wp	516 10.3 Pt
514 9.3 Ra	511 10.7 Rb	517 9.7 Wd	508 9.8 Kn	531 11.8 SR	516 10.0 Ar
514 10.3 So	512 10.6 Pa	517 9.7 Sh	509 9.4 Sh	532 11.6 Me	517 10.2 Pt
517 10.2 So	514 10.4 Ra	517 9.5 Pt	509 9.5 Hf	532 11.6 Gy	517 10.6 Wd
517 9.9 Hf	514 10.6 So	521 10.2 Ar	517 9.4 Hf	533 12.1 SR	517 10.1 Sf
517 9.2 Jo	517 10.5 Jo	522 10.2 Ar	517 8.3 Jo	534 12.0 Me	517 9.8 Wp
517 10.0 Kg	520 10.1 B	522 9.6 Rb	517 9.5 Kn	535 11.9 Me	517 10.0 Wa
519 9.4 B	522 10.8 Rb	522 9.8 Wd	522 9.3 Kn	535 11.9 Wp	517 10.3 Hf
522 9.3 Jo	522 10.6 So	522 9.9 Jo	530 9.2 Kn	535 12.0 B	517 9.9 B
522 9.7 So	532 10.8 Gy	522 10.0 So	530 8.6 My	535 11.9 Wa	519 10.5 Br
527 9.6 Wp	532 11.3 Pt	525 9.9 Ko	530 8.5 Jo	536 12.1 Me	520 10.3 Br
527 9.5 Wa	532 10.7 Jo	526 10.2 Ko	532 9.2 Pt	537 12.1 Me	522 10.0 Rb
528 8.7 Pk	535 10.8 So	526 9.8 Wd	533 9.2 Kn	538 11.8 Me	522 10.2 Ar
529 9.8 Wd	536 11.0 Jo	528 11.0 B	533 8.5 Jo	541 11.4 Wp	525 10.2 Ko
530 10.4 So		528 10.1 Me	535 9.0 Kn	541 11.5 Wa	525 10.3 Gy
530 9.9 My		529 9.5 Pt	536 9.1 Hf		525 10.4 Wp

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1934.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
SU TAU	Z TAU	U ORI	X AUR	U LYN	Y MON
054319	054615a	054920a	060450	063159	065111
525 10.6 Wa	471 13.0 Bm	526 9.0 Wd	514 9.7 Wa	505 14.4 Da	531 10.0 B
526 10.2 Wd	505 13.5 L	526 8.9 Kp	514 9.7 Wp	508 12.9 Br	533 9.7 Sh
527 10.4 Wa	530 13.2 L	527 8.9 Kg	514 9.8 Ra	510[14.3 GC	533 9.9 Hf
527 10.5 Wp	RU TAU	527 8.8 Je	519 9.2 B	514[14.3 Wa	535 9.9 Hf
528 9.9 B	054615c	528 8.8 B	529 9.2 Sf	532 14.2 Da	535 9.8 Wd
528 10.3 Me	471[14.7 Bm	529 9.0 Wd	531 9.1 Sx	R MON	538 10.7 Jo
529 10.4 Wd	505 13.2 L	530 8.6 L	532 8.7 Pt	063308	X MON
529 10.6 Wp	530 12.6 L	530 8.9 Rc	535 8.4 B	501 12.6 Ar	*065208*
529 10.4 Pt	R COL	532 8.8 Jo	536 8.9 Hf	506 12.8 Ar	501 7.4 Pk
529 10.2 Sf	*054629*	532 9.0 Gy	536 8.8 Sf	507 12.8 Ar	503 7.5 Pa
530 10.6 L	486[13.0 En	532 8.8 Pt	η GEM	508 12.5 Ar	507 7.5 Ra
530 10.9 Wd	516[13.0 Bl	533 9.2 Sh	060822	515 12.7 Ar	509 7.3 Se
530 10.8 Wp	519[13.0 Ht	533 9.3 Hf	477 3.5 Lt	516 12.6 Ar	509 8.0 Pa
530 11.0 Wa	α ORI	535 9.0 Hf	483 3.5 Lt	522 12.6 Ar	510 7.9 Hf
531 10.9 Wa	054907	535 9.0 Wd	488 3.6 Lt	528 12.0 B	512 8.1 Pa
531 10.0 B	473 0.3 Sl	535 9.2 Lr	513 3.6 Lt	530 11.4 Jo	512 7.3 Se
531 10.8 Wp	481 0.6 Lt	535 9.0 Kg	532 3.5 Lt	538 11.2 Jo	513 7.8 Pk
531 10.6 Hf	482 0.3 Sl	537 9.5 Wd	V AUR	NOV PIC	513 8.1 Wd
531 10.5 SR	499 0.9 Lt	537 9.0 Jo	061647	*063462*	516 7.6 Jo
531 10.7 Wd	513 0.7 Lt	541 9.3 Mc	517 10.4 So	469 8.8 En	516 8.1 Sx
532 10.6 Gy	U ORI	UW ORI	519 9.7 B	486 8.8 En	517 8.2 Pa
532 10.5 Pt	054920a	054920b	522 9.9 So	503 8.8 Ht	528 8.3 Pk
532 10.4 Me	480 8.9 Oy	512 11.2 Wd	530 9.7 So	512 8.8 Ht	530 8.5 Jo
533 10.5 Pt	502 8.5 Pa	517 10.8 Wd	532 9.8 Gy	519 8.7 Ht	530 8.7 Wd
533 10.2 B	502 8.7 Kp	526 10.4 Wd	533 9.4 Jo	S LYN	532 8.5 Gy
534 10.5 Me	503 8.5 Pa	529 10.5 Wd	537 8.8 Jo	063558	533 8.8 Hf
534 10.5 Pt	505 8.5 Je	537 10.4 Wd	V MON	504 11.0 Ry	535 8.6 Jo
535 10.6 Pt	505 8.1 Sq	V CAM	*061702*	507 11.3 Ry	538 9.0 Jo
535 10.7 Wd	505 8.7 Ah	054974	508 9.3 Sq	510 11.6 Ra	R LYN
535 10.5 Sf	506 8.7 Kp	505[14.2 Da	509 9.4 Pa	510 12.0 GC	065355
535 11.0 Wp	509 8.7 Pa	532[13.8 B	510 9.4 Hf	512 12.2 GC	447 9.1 Da
535 10.8 Wa	509 8.5 Sh	Z AUR	512 9.4 Pa	513 12.4 GC	482 10.2 Da
535 10.7 B	509 8.5 Hf	055353	512 9.5 Ko	514 12.3 Wp	505 10.9 Da
535 10.7 Hf	510 8.6 Kp	516 10.4 Pt	513 9.1 Wd	514 12.5 Wa	510 11.6 Ra
535 10.9 Me	510 8.6 Ra	517 10.0 Jo	516 8.5 Ar	515 11.4 Ry	519 11.8 B
536 10.9 Me	510 8.1 B	519 9.8 B	517 9.2 Pa	519 12.5 B	533 11.9 Da
536 10.7 Hf	510 8.7 Rc	522 9.9 Jo	517 8.6 Jo	530 12.6 GC	RS GEM
536 10.8 Pt	511 8.8 Ah	529 10.3 Pt	530 8.4 Wd	530 12.8 My	065530
537 10.8 Pt	512 8.7 Pa	530 10.2 Jo	530 8.2 Jo	536 12.9 My	511 10.7 Rb
537 11.0 Mw	512 8.5 Kp	532 10.3 Pt	531 8.2 Sx	X GEM	512 10.9 L
537 11.0 Wd	512 8.8 Wd	533 10.0 Jo	532 8.5 Pt	064030	513 11.4 SR
537 11.1 Me	513 8.6 Kp	535 9.8 B	533 8.5 Hf	500 11.7 Bn	514 10.8 So
538 11.2 Me	514 8.6 Kp	538 10.6 Pt	535 7.7 Jo	504 12.0 Bn	530 10.9 So
538 10.8 Pt	514 8.7 Kg	538 10.0 Jo	536 8.3 Ra	512 12.7 L	531 11.4 SR
541 11.8 Wp	514 8.5 Sq	R OCT	538 7.8 Jo	512 12.6 Wd	532 11.3 Jo
541 11.7 Wa	514 8.9 Ah	*055686*	AG AUR	517 12.7 B	532 11.3 Me
546 12.4 Br	515 8.7 Mw	473 10.3 En	062047	532 13.2 B	536 11.6 So
S COL	516 8.9 Sx	476 10.3 En	530 9.4 L	538[11.7 Jo	538 11.5 Jo
054331	516 8.8 Rc	485 10.4 En	UU AUR	Y MON	Z CMA
480 11.9 En	517 8.7 Hf	502 11.2 Bl	062938	065111	*065911*
486 11.6 En	517 8.4 Jo	503 11.1 Ht	448 5.6 Lt	509 10.5 Pa	473 10.0 Sl
502 9.7 Bl	517 8.9 Wd	512 11.4 Ht	449 5.7 Lt	510 9.5 Hf	482 9.7 Sl
503 10.0 Ht	517 8.9 Sh	514 11.2 Bl	474 5.6 Lt	512 10.5 Pa	491 9.7 Sl
512 8.8 Ht	517 8.8 Pa	519 11.6 Ht	484 5.6 Lt	512 9.5 L	496 9.6 Sl
514 9.0 Bl	517 8.8 Kg	523 11.5 Bl	502 5.5 Lt	514 9.5 Ra	V CMI
519 8.6 Ht	522 8.6 Kp	X AUR	512 5.6 Lt	517 9.4 Jo	070109
523 9.0 Bl	522 8.4 Jo	060450	532 5.6 Lt	517 9.7 Pa	504 14.1 Da
	525 9.0 Gy	512 10.0 Hf		530 10.0 Jo	506 14.0 Br

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1934.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V CMI	TW GEM	L_2 PUP	S VOL	R CNC	RT HYA
070109	070122c	*071044*	*073173*	081112	*082405*
512 14.1 L	510 8.4 Ra	491 4.0 Sl	503[13.2 Ht	502 9.5 Sq	510 8.0 GC
515 14.3 Da	512 8.4 Wd	496 4.1 Sl	516[13.2 Bl	503 9.5 Pa	517 7.2 Jo
532[14.0 B	513 8.2 Lt	RR MON	U CMI	505 10.0 Je	522 7.4 Jo
R GEM	517 8.4 Wd	071201	073508	505 9.7 Ah	525 7.3 Ko
070122a	517 8.6 Sh	504 14.4 Da	522 8.8 Jo	507 9.2 Ar	535 7.6 Jo
403 7.4 Da	517 8.4 Sx	512 15.2 L	530 8.7 Jo	508 9.1 Ar	538 7.7 Jo
431 7.3 Da	526 8.4 Wd	533[13.2 SR	531 8.8 Cy	508 9.1 Hi	R CHA
447 6.7 Da	529 8.5 Wd	V GEM	533 8.6 Pt	509 9.6 Hf	*082476*
456 6.6 Da	530 8.5 Wd	071713	533 8.5 Jo	509 9.5 Sh	471[12.6 En
478 7.0 Da	531 8.3 Hf	510 9.0 GC	538 8.6 Jo	511 9.5 Ah	482[12.6 Sl
500 7.1 Da	532 8.3 Lt	512 9.0 GC	S GEM	512 8.3 Sq	503[12.6 Ht
503 7.8 Pa	533 8.2 Pt	513 8.8 GC	*073723*	512 9.1 Pa	516[12.6 Bl
505 8.6 Je	533 8.2 Da	518 8.6 Br	506 10.5 Br	513 9.3 Wp	U CNC
505 7.8 Ah	535 8.7 Lr	528 8.8 B	512 10.0 Hf	513 9.2 Wa	083019
510 7.8 Hf	535 8.6 Kg	530 9.1 GC	513 10.1 Wp	513 8.9 Jo	510 10.0 GC
510 8.2 Ra	537 8.3 Wd	533 9.0 Pt	513 10.0 Wa	514 9.2 Wa	513 10.1 GC
511 8.5 Ah	537 8.5 Sx	535 9.0 GC	532 11.5 B	514 9.3 Wp	530 10.0 GC
512 7.9 L	R CMI	538 8.8 Jo	533 11.7 Pt	514 9.2 Ra	531 9.7 Cy
512 8.1 Wd	070310	S CMI	535 11.7 Hf	515 8.8 Ar	533 9.7 Jo
513 8.3 Wp	478 8.2 Da	072708	W PUP	516 8.8 Ar	535 9.5 GC
513 8.3 Wa	480 8.2 Oy	500 9.7 Wh	*074241*	517 9.1 Pa	535 9.8 Sf
513 8.0 Jo	504 7.4 Da	502 9.8 Ko	471 9.2 En	517 9.1 Hi	X UMA
514 8.0 Ah	505 7.8 Sq	503 10.0 Pa	476 8.5 En	517 9.3 Hf	083350
517 8.3 Sh	505 8.1 Ah	509 9.7 Pa	486 8.5 En	522 8.8 Jo	510 10.9 Hf
517 8.4 Wd	509 8.3 Hf	509 9.7 Sh	502 8.5 Bl	522 8.7 Ar	513 10.6 Jo
517 7.9 Pa	509 8.2 Sh	509 9.7 Hf	503 8.9 Ht	529 8.8 Ah	S HYA
517 8.3 Kg	511 8.1 Ah	512 9.6 Pa	512 9.2 Ht	530 8.7 Sx	084803
517 8.5 Sx	512 8.5 Pa	513 8.9 Jo	514 9.1 Bl	531 8.8 Cy	510 10.6 GC
526 8.6 Wd	512 8.0 L	514 9.2 Wp	519 9.4 Ht	532 8.7 Jo	510 11.1 Hf
527 8.6 Kg	513 8.0 Wp	514 9.4 Wa	523 9.8 Bl	533 8.9 Wh	512 10.9 Hf
527 8.9 Je	513 8.0 Wa	517 9.5 Hf	T GEM	533 8.6 Pt	512 10.4 Pa
529 8.6 Wd	513 7.7 Jo	517 9.5 Pa	074323	535 8.8 Wd	513 10.5 GC
530 8.7 Wd	514 8.2 So	517 8.9 Jo	479 8.0 Da	535 8.5 Mw	517 10.4 Pa
530 8.4 Jo	514 8.2 Ah	526 9.2 Ko	522 9.6 Jo	535 8.8 Hf	530 9.9 GC
530 8.9 Pe	517 8.4 Hf	528 9.0 B	525 9.6 Gy	536 8.8 Sf	533 9.5 Pt
531 8.7 Hf	517 7.7 Jo	528 9.1 Ra	530 9.9 Jo	538 8.5 Jo	533 9.6 Jo
532 8.5 B	530 8.2 Jo	530 8.9 Jo	533 10.1 Jo	540 8.8 Wd	535 9.5 Jo
533 8.5 Pt	530 8.8 Wd	533 8.9 Jo	533 9.8 Da	V CNC	535 9.7 Hf
533 8.1 Da	530 8.5 So	533 9.1 SR	533 10.5 Pt	081617	537 9.5 Mw
533 8.4 Jo	530 8.5 Pe	533 9.1 Pt	535 10.4 B	479 8.7 Da	538 9.0 Jo
535 8.8 Kg	530 8.5 Sx	533 8.8 Sh	538 10.4 Jo	500 9.1 Pk	T HYA
535 8.7 Lr	532 8.3 B	533 8.9 Hf	539 11.8 Mw	504 9.2 Da	*085008*
537 8.9 Wd	532 8.4 Gy	535 9.0 Hf	U PUP	505 9.7 Ah	501 7.9 Bc
537 8.8 Sx	533 8.3 Sh	538 9.0 Jo	*075612*	509 9.6 Sh	507 7.9 Bc
538 9.2 Wd	533 8.2 Jo	T CMI	513[13.5 GC	509 9.7 Hf	510 8.3 GC
538 8.8 Jo	533 8.0 Da	072811	532[13.0 B	511 9.9 Ah	510 8.0 Hf
Z GEM	533 8.5 Hf	506 11.4 Br	539[12.0 Mw	514 10.0 Ra	512 7.5 Se
070122b	535 8.6 Mw	513 11.6 Wp	RV CNC	517 10.2 Hf	517 7.6 Jo
510 11.2 Ra	537 8.6 Mw	513 11.7 Wa	080319	519 9.8 Br	530 7.8 Sx
512 12.4 Wd	538 8.3 Jo	528 11.7 B	505 12.0 Br	531 10.8 Cy	531 8.0 Hf
517 12.3 Wd	R VOL	533 11.8 Pt	506 11.9 Br	532 10.6 Gy	531 7.8 Cy
530 12.4 Wd	*070772*	Z PUP	508 12.0 Br	533 10.1 Da	531 8.0 Wd
533 12.5 Pt	476[13.4 En	*072820b*	510 12.0 Br	535 11.2 Wd	533 7.9 Sh
537 12.4 Wd	503[13.4 Ht	486[12.6 En	518 11.9 Br	535 11.2 Hf	535 7.7 Jo
TW GEM	519[13.4 Ht	510[13.0 GC	519 11.9 Br	537 11.3 Mw	537 8.2 Mw
070122c	L_2 PUP	532[12.4 Gy	R CNC	540 11.4 Wd	538 8.1 Jo
481 8.3 Lt	*071044*	S VOL	081112	RT HYA	T CNC
502 8.2 Lt	473 4.0 Sl	*073173*	480 9.4 Oy	*082405*	085120
510 8.2 Hf	482 3.8 Sl	476[13.2 En	501 9.5 Ar	502 7.5 Ko	513 8.5 Jo

Variable Star Observations Received During April, 1934.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs
T Cnc	R Car	R Leo	RR Car	R UMa	W Leo
085120	*092962*	094211	*095458*	103769	104814
522 8.5 Jo	523 5.6 Bl	514 9.0 Kg	484 7.4 En	508 8.5 Hi	479 13.0 Bm
531 9.5 Cy	X Hya	514 9.1 Ra	503 7.2 Ht	508 8.0 Wg	485 13.2 Bm
532 8.4 Jo	*093014*	514 8.8 So	512 7.1 Ht	508 8.2 Sq	494 13.1 Bm
533 8.3 Pt	479 12.1 Bm	516 8.9 Ah	519 7.2 Ht	510 8.6 Ra	506 13.4 Br
S Pyx	481 12.0 Bm	516 9.1 Sx	RV Car	510 8.6 Hf	510 13.5 GC
090024	510 11.0 Gg	517 9.1 Pa	*095563*	511 8.5 Ah	513 13.5 GC
471 11.1 Bm	510 10.6 GC	517 8.9 Kg	484[13.1 En	512 8.5 B	536 13.6 So
481 10.0 Bm	510 10.7 Rc	517 9.1 Wp	503[13.1 Ht	512 8.7 Wd	RS Car
510 10.6 GC	511 10.9 Rc	517 8.9 Wd	516[13.1 Bl	513 8.2 Jo	*110361*
512 10.3 Ko	512 11.1 Hf	526 9.2 Kp	S Car	513 8.6 Sx	484[12.3 En
513 10.4 GC	513 10.4 GC	528 8.3 Pk	*100661*	513 8.1 Sz	S Leo
514 10.6 Rc	531 10.3 Rc	529 9.1 Ah	469 6.2 En	516 8.4 Ah	110506
537 11.1 Rc	532 10.2 Gy	530 9.5 Pe	473 6.0 Sl	517 8.8 Wd	513 12.9 GC
T Pyx	533 10.3 Pt	530 9.6 Kg	482 6.0 Sl	517 8.5 Jo	536[13.0 So
090031	535 9.8 Jo	530 9.6 So	484 6.4 En	522 8.5 Jo	RY Car
516 [t Bl	536 9.7 Hf	530 9.7 Wd	491 6.2 Sl	522 8.9 Hf	*111561*
V UMa	Y Dra	531 8.7 SR	496 6.3 Sl	522 9.0 Wd	476 13.1 En
090151	093178	532 9.6 Me	502 6.9 Bl	526 8.9 Wd	484[13.1 En
510 10.0 GC	505 13.5 Br	533 9.0 Jo	503 6.9 Ht	527 8.9 Kg	503[13.1 Ht
513 10.0 Jo	537 9.7 Jo	533 9.4 Ah	512 7.5 Ht	527 8.8 Je	515 13.5 Bl
517 10.1 Jo	R LMi	533 9.4 Pt	515 7.4 Bl	529 9.0 Ah	519[13.1 Ht
530 10.2 GC	093934	535 9.7 Kg	519 7.7 Ht	530 8.8 Cy	RS Cen
535 10.0 GC	506 12.9 Br	535 9.7 Mw	523 7.9 Bl	532 8.9 B	*111661*
536 9.8 So	508 12.6 Hi	535 9.5 Ba	U UMa	533 9.5 Ah	476 9.5 En
W Cnc	517 12.5 Hi	535 9.6 Lr	100860	533 9.3 Wd	480 9.3 En
090425	533 12.0 Pt	536 9.9 So	481 6.4 Lt	533 9.0 Pt	484 9.0 En
506 13.2 Br	RR Hya	536 9.9 Hf	502 6.4 Lt	535 9.0 Mw	495 8.9 En
514 13.3 Wp	*094023*	537 9.9 Mw	513 6.5 Lt	535 9.5 Mc	502 9.1 Bl
514 13.2 Wa	479 12.0 Bm	538 9.0 Jo	532 6.4 Lt	535 9.5 Jo	503 8.9 Ht
515 13.4 Ar	481 10.8 Bm	539 9.9 Mw	Z Car	536 9.4 Hf	512 9.2 Ht
516 13.4 Ar	484 11.0 En	L Car	*101058a*	536 9.6 Wd	515 9.1 Bl
519 13.1 Br	510 9.6 GC	*094262*	480 11.6 En	536 9.7 So	519 9.3 Ht
RW Car	532 8.9 Jo	476 4.1 En	486 11.4 En	537 9.9 Mw	523 9.4 Bl
091868	537 9.8 Mw	484 3.6 En	495 11.6 En	537 9.6 Jo	X Cen
476 11.9 En	R Leo	486 3.7 En	502 11.6 Bl	540 9.7 Wd	*114441*
484 12.0 En	094211	494 4.3 En	503 11.5 Ht	545 10.3 SR	485 8.4 En
503 12.9 Ht	480 8.8 Oy	495 4.0 En	512 11.8 Ht	V Hya	502 8.7 Bl
516[12.8 Bl	500 7.9 Pk	Y Hya	515 11.8 Bl	*104620*	503 8.8 Ht
Y Vel	501 8.4 Sq	*094622*	519 11.9 Ht	502 7.7 Bl	512 8.5 Ht
092551	503 8.9 Pa	480 7.0 En	523 12.1 Bl	513 7.5 Jo	515 8.8 Bl
484[12.9 En	505 8.8 Je	512 6.5 Se	W Vel	513 7.3 Ko	519 9.3 Ht
502 13.2 Bl	505 9.8 Ah	Z Vel	*101153*	515 7.7 Bl	523 9.3 Bl
515 12.4 Bl	506 9.2 Kp	*094953*	484[13.0 En	516 7.7 Jo	AD Cen
523 12.1 Bl	510 9.4 Kp	482 11.9 Sl	503[13.0 Ht	517 8.1 Rc	*114858*
R Car	510 9.2 Hf	484 11.4 En	516 12.8 Bl	522 7.4 Jo	503 9.3 Ht
092962	511 9.0 Ah	491 11.7 Sl	523 13.0 Bl	523 7.5 Bl	512 9.3 Ht
472 4.7 En	512 9.0 Pa	502 11.2 Bl	U Hya	531 8.2 Rc	519 9.3 Ht
473 4.5 Sl	512 9.0 Kp	503 11.8 Ht	*103212*	532 7.3 Jo	W Cen
482 4.3 Sl	512 8.6 Sq	512 11.1 Ht	512 5.2 Se	533 7.2 Jo	*115058*
484 4.5 En	512 8.9 Wd	515 10.8 Bl	RZ Car	535 7.5 Jo	476 8.6 En
491 4.3 Sl	513 8.8 Pa	519 10.9 Ht	*103270*	535 9.5 Mw	485 9.1 En
494 4.7 En	513 9.3 Kp	523 10.4 Bl	484[13.1 En	536 7.6 Jo	495 9.3 En
496 4.4 Sl	513 9.4 SR	V Leo	519[13.1 Ht	RS Hya	502 10.1 Bl
502 4.5 Bl	513 8.6 Sz	095421	R UMa	*104628*	503 10.5 Ht
503 4.6 Ht	513 9.0 Sh	506 13.7 Br	103769	510 13.0 GC	512 11.4 Ht
512 5.1 Ht	513 8.8 Jo	510 13.9 GC	503 8.0 Wg	513 12.9 GC	515 11.0 Bl
515 5.4 Bl	514 9.3 Kp	513 14.0 GC	505 8.3 Je	516 13.0 Bl	519 11.7 Ht
519 5.5 Ht		533[12.6 Pt	505 8.3 Ah		523 11.7 Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1934.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
X UMA	R CRV	T UMA	S UMA	U OCT	RT CEN
115158	*121418*	123160	123961	*131283*	*134236*
525 8.8 Rb	537 7.8 Mw	508 11.4 Br	507 8.5 Wg	503 13.4 Ht	502 9.0 Bl
R COM	537 8.0 Jo	510 11.0 Ra	510 8.6 Ra	512 13.4 Ht	503 9.4 Ht
115919	538 8.2 Wd	511 11.7 Ah	510 8.6 Hf	516 13.2 Bl	512 9.5 Ht
510 8.7 Hf	541 7.9 Mc	512 11.5 Wd	511 8.5 Ah	519 13.3 Ht	515 9.2 Bl
513 8.4 Jo	RY UMA	512 12.1 Fd	512 8.5 Wd	V VIR	519 9.5 Ht
514 8.6 Wa	121561	513 12.1 Jo	512 8.9 Rc	*132202*	524 9.2 Bl
514 8.7 Wp	481 7.5 Lt	516 11.8 Ah	512 8.3 Sq	505 9.0 L	R CVN
516 8.5 Jo	503 7.6 Lt	517 12.4 Jo	513 8.7 Sz	514 9.2 Ko	134440
518 8.5 B	516 7.6 Lt	518 11.8 B	513 8.6 Sx	522 9.8 Hf	513 10.3 Sz
522 8.6 Jo	532 7.5 Lt	530 12.4 Wd	513 8.3 Jo	532 10.0 Jo	514 10.3 Ra
529 8.5 Wp	SS VIR	530 12.5 Pe	516 8.8 Ah	535 10.1 Hf	514 10.5 Ah
530 8.9 Jo	122001	533 12.4 Pt	517 8.7 Jo	535 10.2 Wd	517 10.6 Jo
531 8.8 Cy	505 8.4 L	536 12.4 So	518 9.1 B	537 10.3 Mw	532 11.6 Jo
535 8.8 Wa	513 8.5 Sz	537 12.5 Gy	519 9.0 Rc	R HYA	533 11.5 Pt
535 8.6 Wp	513 8.5 Jo	537 12.6 Wd	522 9.2 Hf	*132422*	535 11.6 Jo
535 9.0 Jo	516 8.0 Jo	R VIR	522 9.2 Wd	502 7.3 Bl	536 11.2 So
536 8.9 Hf	522 7.7 Jo	123307	522 8.9 Jo	503 7.1 Ht	538 11.8 Jo
536 9.0 So	522 9.1 Hf	505 11.7 L	526 9.3 Wd	505 7.5 L	RX CEN
537 9.0 Jo	532 7.8 Jo	512 11.7 Rc	527 9.4 Je	512 7.1 Ht	*134536*
SU VIR	534 8.8 B	513 11.0 Sz	527 9.3 Kg	515 7.5 Bl	503[13.1 Ht
120012	535 8.7 Wd	517 11.4 Rc	529 9.2 Rc	519 7.1 Ht	516[13.1 Bl
505 10.6 L	535 7.7 Jo	518 11.2 B	529 9.3 Ah	524 7.3 Bl	T APS
513 10.5 Sz	535 8.9 Hf	530 9.5 Rc	530 9.8 Pe	533 7.5 Pt	*134677*
518 10.0 B	535 8.8 Mw	533 9.3 Jo	530 9.8 Wd	535 7.1 Jo	473 10.4 En
522 9.4 Jo	536 9.4 So	533 9.1 Ah	530 9.5 Jo	536 7.0 Jo	485 9.3 En
532 9.8 Jo	537 9.2 Mw	533 9.3 Pt	532 10.2 Gy	537 7.0 Jo	502 9.2 Bl
535 10.0 Jo	537 7.6 Jo	535 9.0 Mw	533 9.6 Da	538 7.2 Jo	503 9.3 Ht
535 10.0 Wp	544 8.8 Md	535 8.8 Wd	533 10.1 Pt	S VIR	512 9.0 Ht
535 10.2 Wa	T CVN	535 9.1 Ba	534 9.5 B	*132706*	515 8.8 Bl
536 10.0 My	122532	535 9.0 Hf	535 10.0 Mc	505 13.1 L	519 9.2 Ht
537 10.2 Jo	510 10.6 Rc	535 9.0 Jo	536 9.8 Jo	514[12.0 Ra	524 8.5 Bl
T VIR	513 10.7 Rc	536 9.0 Rc	536 10.3 So	519[12.3 Ht	RR VIR
120905	513 10.4 Jo	537 8.5 Jo	536 10.3 Hf	537 12.4 Jo	*135908*
505 13.5 L	516 10.5 Jo	537 8.9 Mw	537 10.3 Gy	RV CEN	505 12.0 L
534 13.4 B	516 10.6 Hi	RS UMA	537 10.2 Wd	*133155*	512 12.0 Fd
R CRV	522 10.8 Jo	123459	RU VIR	495 7.8 En	Z BOO
121418	530 11.3 Rc	479 13.7 Bm	124204	502 7.8 Bl	140113
479 12.7 Bm	533 11.3 Pt	485 13.6 Bm	505 14.2 L	503 8.2 Ht	512 13.6 Fd
485 12.4 Bm	533 11.4 Jo	494 13.9 Bm	535 13.8 Wp	512 8.1 Ht	535 12.0 Jo
491 11.7 Sl	534 11.4 B	504 13.5 Bn	535 13.7 Wa	515 8.5 Bl	Z VIR
494 11.8 Bm	535 11.4 Jo	508 13.7 Br	541 13.9 Wa	519 8.2 Ht	*140512*
512 10.1 Wd	538 11.5 Jo	512 13.4 Fd	541 13.8 Wp	524 7.8 Bl	505 10.9 L
513 10.2 Jo	Y VIR	512 13.5 Wd	U VIR	T UMI	533 11.5 Jo
516 9.6 Jo	*122803*	530 12.8 Wd	*124606*	133273	RU HYA
517 9.2 Jo	479 10.2 Bm	530 12.8 Pe	505 12.8 L	506 13.7 Br	*140528*
519 9.1 B	485 10.1 Bm	533 12.6 Pt	531 11.4 B	T CEN	502 12.3 Bl
522 8.6 Hf	494 10.4 Bm	536 12.8 So	533 11.4 Pt	*133633*	512 11.2 Ht
522 8.7 Jo	505 10.8 L	537 12.4 Gy	535 11.3 Hf	482 6.7 Sl	515 10.8 Bl
529 8.7 Wd	518 11.7 B	537 12.6 Wd	535 11.2 Wd	491 6.1 Sl	519 10.7 Ht
530 8.2 Wd	U CEN	S UMA	RV VIR	502 6.0 Bl	524 9.1 Bl
530 8.2 Pe	*122854*	123961	*130212*	503 5.9 Ht	R CEN
532 8.3 Jo	485[12.3 En	403 9.5 Da	505[13.8 L	512 6.2 Ht	*140959*
533 7.8 Pt	516 13.4 Bl	447 7.9 Da	512[13.8 Fd	515 6.4 Bl	482 6.6 Sl
533 8.1 Wd	T UMA	502 8.3 Sq	U OCT	519 6.7 Ht	485 6.4 En
535 7.7 Mw	123160	503 8.5 Wg	*131283*	524 6.5 Bl	491 6.2 Sl
535 8.2 Jo	503 12.0 Wg	505 8.1 Da	485 13.6 En	532 7.5 Lt	495 6.2 En
536 8.5 Wd	505 11.4 Ah	505 8.7 Je			502 6.1 Bl
536 8.1 Hf	507 12.0 Wg	505 8.5 Ah			503 6.2 Ht

Variable Star Observations Received During April, 1934.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
R Cen			R Cam			Y Lup			W Lib			R CrB			R CrB		
140959			142584			*145254*			*153215*			154428			154428		
512	5.9	Ht	513	8.4	Jo	524	10.7	Bl	516	12.5	L	509	6.2	Rb	525	6.1	Gy
515	6.3	Bl	517	8.3	Jo	S Aps			516	12.6	Bl	509	6.0	Cy	525	6.5	Rb
519	5.9	Ht	518	8.4	Br	*145971*			S UMi			510	6.0	Kp	525	6.3	Kp
524	6.2	Bl	522	8.4	Jo	482	10.3	Sl	153378			510	6.2	Cy	526	6.1	Wd
U UMi			530	8.4	Jo	491	10.4	Sl	510	9.6	Ra	511	6.3	Ah	526	6.1	Cy
141567			533	8.4	Jo	496	10.4	Sl	510	9.8	Hf	511	6.1	Rb	528	6.4	Ah
505	8.6	Ah	533	8.2	Da	502	10.5	Bl	512	9.8	Fd	512	6.1	Kp	528	6.1	Me
510	8.8	Hf	533	8.7	Wd	503	10.2	Ht	512	9.5	Ko	512	6.0	Hf	528	6.0	Pk
510	9.0	Ra	536	8.4	Wd	512	10.1	Ht	513	8.4	Jo	512	6.1	Wd	529	6.1	Me
511	8.8	Ah	538	8.3	Jo	515	10.3	Bl	517	8.6	Jo	513	6.0	Kp	530	6.1	Sx
512	8.8	Fd	540	8.4	Wd	519	10.1	Ht	517	9.9	Hf	513	6.0	Ko	530	6.0	Kg
513	8.5	Jo	R Boo			524	10.2	Bl	522	8.8	Jo	513	5.9	Pt	530	5.9	Ra
516	8.6	Jo	143227			T Lib			529	9.7	Hf	513	6.3	Rb	530	6.2	Cy
517	9.3	Hf	505	9.2	Ah	*150519*			532	8.8	Jo	513	6.0	Si	530	6.1	Wd
522	8.8	Jo	511	8.8	Ah	505	12.3	L	535	9.8	Hf	513	6.0	Rc	530	6.0	Rc
529	9.6	Hf	512	8.6	Wd	536	11.1	Pt	535	9.4	Wd	513	6.0	Jo	530	6.0	Jo
531	9.4	Hi	512	9.2	Hf	Y Lib			535	9.4	Sf	514	6.2	Ah	530	6.1	Pe
532	9.2	Jo	512	8.7	Fd	*150605*			536	9.2	Pt	514	6.5	Kp	531	6.1	Cy
533	9.8	Ah	513	8.5	Sz	536	11.7	My	537	9.0	Jo	514	6.0	Ko	531	6.2	SR
533	10.2	Pt	514	8.6	Ra	S Lib			U Lib			514	6.3	SR	531	6.1	L
536	9.6	Sf	514	8.9	Ah	*151520*			*153620a*			514	5.9	Pt	531	6.1	Si
537	9.3	Jo	516	8.8	Ah	505	9.3	L	516	12.6	L	514	6.0	Ra	532	6.3	Pt
S Boo			516	8.3	Jo	520	9.8	Jo	516	13.0	Bl	515	5.9	Pt	532	6.0	Jo
141954			522	8.1	Jo	S CrB			T Nor			515	6.2	Ar	532	6.4	Me
533	12.4	Pt	528	8.1	Ah	151731			*153654*			516	6.3	Ah	532	6.0	Gy
535	12.3	SR	529	7.8	Hf	503	12.1	L	512	12.7	Ht	516	6.4	Kp	533	6.2	Jo
536	12.0	Ra	530	8.3	Wd	506	12.0	Gg	RR CrB			516	6.0	Pt	533	6.2	SR
537	12.2	Gy	530	7.7	Jo	512	11.6	Fd	153738			516	6.1	L	533	6.4	Pt
RS Vir			530	8.1	Pe	512	10.3	Wd	482	7.9	Lt	516	6.1	Rc	533	6.6	Ah
142205			533	7.7	Pt	514	10.8	Ra	490	7.8	Lt	516	6.0	Cy	534	6.3	Me
479	11.6	Bm	533	7.4	Jo	514	11.5	Ko	503	7.6	Lt	516	6.0	Jo	534	6.3	Pt
485	12.2	Bm	533	7.9	Ah	535	10.6	Ba	508	7.3	Lt	517	6.0	Jo	535	6.7	SR
494	12.4	Bm	535	7.4	Mw	536	12.3	Pt	513	7.8	Lt	517	6.0	Hf	535	6.0	Kg
V Boo			537	7.5	Mw	RS Lib			515	8.0	Lt	517	6.2	Me	535	6.3	Pt
142539a			537	7.0	Jo	*151822*			532	7.8	Lt	517	6.5	Kp	535	6.0	Mw
480	8.8	Oy	538	7.4	Me	505	9.8	L	Z Lib			517	6.0	Pt	535	6.1	Wd
506	9.2	Gg	V Lib			512	10.0	Ht	*154020*			517	6.2	Se	535	6.1	Ra
510	8.7	Hf	*143417*			515	9.7	Bl	516	12.7	Bl	517	6.3	Rb	535	6.1	Hf
512	9.1	Fd	505	10.7	L	519	9.8	Ht	R CrB			517	6.0	Sh	535	6.1	Jo
514	8.7	Ra	S Lup			520	9.0	Jo	154428			517	6.1	Wd	536	5.8	Jo
516	8.4	Jo	*144646a*			524	9.2	Bl	478	6.0	Cy	517	6.0	Rc	536	6.3	Pt
522	8.3	Jo	512	12.1	Ht	RU Lib			480	6.0	Si	518	6.2	Se	536	6.4	Me
528	7.5	Pk	X Lup			*152714*			481	6.2	Si	518	6.2	Me	537	6.2	Pt
530	8.2	Jo	*144646b*			505	12.5	L	481	6.1	Oy	519	6.2	SR	537	6.1	Mw
530	8.1	Cy	519	12.1	Ht	535	10.6	Hf	482	6.0	Cy	519	6.2	Rb	537	6.2	Gy
533	7.9	Jo	U Boo			536	10.4	Pt	485	6.1	Si	519	6.2	Se	537	5.9	Jo
533	8.4	Pt	144918			R Nor			497	6.0	Cy	520	6.0	Jo	538	6.0	Jo
535	7.1	Mc	513	10.2	GC	152849			502	6.2	Rb	521	6.1	Me	538	6.1	Rc
535	8.2	Sf	531	10.2	Cy	502	11.9	Bl	503	6.1	L	521	6.1	Ar	538	6.3	Pt
536	8.0	Hf	532	10.4	Jo	512	12.5	Ht	503	5.8	Ko	522	6.5	Kp	538	6.5	Me
536	8.2	Me	536	10.6	Jo	515	12.2	Bl	504	6.2	Rb	522	6.1	Hf	542	6.0	Kg
537	7.8	Jo	Y Lup			519	12.5	Ht	505	6.2	Ah	522	6.0	Jo	542	6.1	Ba
R Cam			*145254*			X Lib			506	6.0	Gg	522	6.5	Rb	545	6.7	SR
142584			502	10.0	Bl	*153020*			506	6.1	Ar	523	6.0	Pk	547	6.6	Ba
479	10.6	Da	503	9.9	Ht	516	12.6	L	506	6.5	Rb	524	6.2	Ar	X CrB		
480	8.7	Oy	512	10.4	Ht	516	12.6	Bl	507	6.1	Ar	524	6.2	Me	154536		
505	8.7	Da	515	10.2	Bl				507	6.1	Si	524	6.0	Pk	483	11.3	L
508	8.8	Br	519	10.7	Ht				508	6.0	Cy	525	6.1	Ko	503	10.6	L

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1934.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
X CrB	Z Sco	SX Her	W CrB	g Her	R Dra
154536	*160021*	160325	161138	162542	163266
517 9.5 Jo	503 11.4 L	535 8.3 Hf	517 9.0 Jo	532 5.4 Lt	537 7.5 Wd
532 9.3 Jo	512 11.5 Ht	535 8.0 Pt	522 10.2 Hf	SS Her	RR Oph
535 9.5 Jo	516 11.1 Bl	535 8.2 Jo	530 10.0 Jo	162807	*164319*
536 8.8 Pt	519 11.6 Ht	535 7.8 Me	531 11.1 Ra	483 9.2 L	479 12.4 Bm
538 9.4 Jo	R Her	536 7.8 Me	535 10.8 Wd	490 9.9 L	485 12.8 Bm
R Ser	160118	536 8.0 Pt	535 10.7 Hf	503 11.6 L	486 11.2 L
154615	483 14.6 L	537 8.0 Pt	535 10.8 Jo	536 12.2 Pt	494 12.8 Bm
483 8.6 L	489 14.5 L	537 8.2 Jo	536 10.5 Pt	539 12.0 Fd	516 14.0 L
489 9.0 L	539 13.0 Fd	538 8.0 Pt	538 11.0 Jo	T Oph	536[12.0 Pt
503 9.8 L	U Ser	538 8.0 Me	W Oph	*162815*	S Her
505 10.3 Ah	160210	540 8.3 Wd	*161607*	486 12.0 L	164715
511 10.4 Ah	483 13.0 L	W Sco	483 11.3 L	516 11.5 L	503 9.5 L
532 11.0 Jo	489 11.9 L	*160519*	490 11.7 L	S Oph	505 9.7 Ah
535 11.5 Jo	503 10.9 L	516 14.7 L	516 12.1 L	*162816*	511 9.8 Ah
536 11.6 Pt	514 10.9 Ra	RU Her	V Oph	486 10.9 L	536 11.4 Pt
538 11.6 Jo	522 10.1 Hf	160625	*162112*	516 9.7 L	536 11.2 My
V CrB	529 10.2 Hf	485 8.0 L	483 7.6 L	W Her	539 10.8 Fd
154639	532 9.5 Jo	490 8.1 L	490 7.7 L	163137	RS Sco
483 9.2 L	535 9.7 Jo	503 8.8 L	516 7.3 L	486 11.3 L	*164844*
503 9.2 L	535 9.5 Hf	512 9.2 Wd	517 7.0 Jo	503 11.9 L	512 10.3 Ht
517 9.5 Jo	536 9.2 Pt	514 9.0 Ra	518 7.3 Se	506 12.4 Ar	516 10.0 Bl
522 9.5 Jo	536 9.0 My	514 9.8 Ko	535 7.9 Hf	536 12.8 Pt	519 10.5 Ht
530 9.9 Jo	538 9.5 Jo	517 9.8 Me	536 7.4 Pt	539 13.0 Fd	524 10.1 Bl
535 9.7 Jo	539 9.2 Fd	521 9.8 Me	U Her	R UMi	RR Sco
536 10.3 So	X Sco	522 10.0 Hf	162119	163172	*165030a*
536 9.1 Pt	*160221a*	524 10.4 Me	483 10.1 L	510 9.7 Hf	512 7.4 Ht
538 9.7 Jo	483 10.7 L	529 10.6 Me	490 8.9 L	513 9.4 Jo	516 7.4 Bl
544 10.4 Md	490 10.6 L	529 10.2 Hf	503 8.1 L	517 9.6 Jo	519 7.2 Ht
R Lib	516 10.5 Bl	532 10.4 Gy	505 8.4 Ah	517 9.8 Hf	RV Her
154715	516 10.5 L	532 10.4 Me	513 7.8 Jo	522 9.4 Jo	165631
482 14.1 L	SX Her	533 9.6 Jo	514 8.8 Ah	528 9.4 Ra	539 13.4 Fd
516[13.8 L	160325	535 9.8 Jo	516 8.4 Ah	529 9.6 Hf	RT Sco
RR Lib	477 8.8 Lt	535 10.3 Hf	522 8.1 Hf	530 9.5 Jo	*165636*
155018	485 8.4 L	536 10.2 Pt	525 8.1 Gy	535 9.1 Jo	516[13.0 Bl
482 10.6 L	490 8.5 L	537 10.0 Jo	528 8.1 Ah	538 9.2 Me	R Oph
490 11.4 L	490 9.0 Lt	538 10.6 Me	529 8.1 Hf	R Dra	*170215*
516 12.8 L	503 8.1 L	539 10.0 Fd	530 8.0 Jo	163266	486 13.1 L
536[11.9 Pt	508 9.0 Lt	540 10.5 Wd	532 8.7 Gy	510 8.2 Hf	516 12.8 L
Z CrB	512 8.2 Wd	R Sco	533 8.1 Ah	511 8.2 Ah	537 11.7 Gy
155229	513 8.7 Lt	*161122a*	535 7.9 Jo	512 7.9 Fd	RT Her
483 9.4 L	514 8.0 Ra	479 11.5 Bm	535 8.1 Hf	513 8.1 Wd	170627
503 10.8 L	516 8.1 Pt	483 12.0 L	536 8.3 Ra	513 7.7 Jo	507 9.4 Pf
T CrB	517 7.9 Pt	485 11.6 Bm	536 7.7 Pt	514 8.1 Ah	513 9.2 Jo
155526	517 8.1 Me	490 12.3 L	537 8.1 Gy	516 7.9 Ah	514 10.2 Ko
536 9.8 Pt	518 8.1 Me	494 12.2 Bm	537 7.8 Jo	517 7.5 Jo	536 11.2 Pt
RZ Sco	521 8.0 Me	516 14.0 L	539 8.0 Fd	517 7.9 Hf	RW Sco
155823	522 8.0 Hf	536[12.6 Pt	Y Sco	522 7.4 Jo	*170833*
482 10.3 L	522 8.0 Jo	S Sco	*162319*	526 7.8 Wd	516 12.5 Bl
490 10.3 L	524 8.1 Me	*161122b*	486 12.7 L	527 7.6 Kg	Z Oph
512 8.9 Ht	528 8.0 Me	485[14.3 Bm	516 12.4 L	528 7.7 Ah	171401
516 8.4 L	529 8.0 Me	490[13.5 L	g Her	528 8.0 Ra	536 11.0 Pt
519 9.0 Ht	529 8.1 Hf	512[12.6 Ht	162542	529 7.6 Wd	538 10.4 Jo
536 9.1 Pt	532 8.0 Pt	516 13.8 L	477 5.4 Lt	529 7.8 Hf	RS Her
537 8.9 Jo	532 8.0 Lt	536 12.5 Pt	482 5.2 Lt	530 7.4 Pe	171723
Z Sco	532 8.0 Me	W CrB	490 5.4 Lt	530 7.6 Jo	535 9.2 Jo
160021	533 8.0 Jo	161138	503 5.4 Lt	533 7.8 Ah	536 9.1 Pt
483 11.8 L	533 8.0 Pt	503 8.6 L	508 5.4 Lt	535 7.4 Jo	
490 11.8 L	534 8.0 Pt	513 8.8 Jo	515 5.3 Lt	536 7.4 Pt	

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1934.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RS HER	T HER	RZ HER	NOV AQL	RS LYR	S SGR
171723	180531	183225	184300	190933a	*191319a*
538 8.8 Jo	522 8.6 Hf	503 12.3 L	537 11.0 Jo	531 13.7 L	536 11.7 Me
S OCT	524 8.2 Me	X OPH	537 11.5 Pt	RU LYR	TZ CYG
172486	525 8.8 Gy	183308	RX LYR	190941	191350
473 12.8 En	528 8.9 Ah	508 7.4 Cy	185032	531 12.0 L	520 10.5 Jo
482 12.3 Sl	529 9.0 Hf	513 7.0 Jo	503 12.5 L	537 12.1 Pt	537 10.7 Pt
485 12.3 En	532 9.3 Gy	514 7.4 Ko	506 13.2 Ar	U DRA	538 11.0 Jo
491 11.8 Sl	533 9.2 Ah	517 7.3 Se	537[13.0 Pt	190967	U LYR
502 9.8 Bl	535 9.6 Hf	517 7.5 Cy	S CRA	506 11.0 Pf	191637
503 10.1 Ht	536 9.9 Me	517 7.1 Jo	*185437a*	518 10.0 Pf	518 10.9 Me
512 9.1 Ht	536 9.6 Ra	520 7.2 Jo	512 11.7 Ht	520 9.0 Jo	520 9.7 Jo
515 8.7 Bl	536 9.6 Pt	537 7.4 Jo	519 11.7 Ht	522 9.6 Jo	531 9.5 L
519 8.7 Ht	537 9.7 Gy	537 7.9 Pt	R CRA	528 9.7 Ra	536 11.3 Ra
524 8.4 Bl	539 10.1 Fd	RY LYR	*185537a*	530 9.8 Jo	537 10.1 Jo
RU OPH	W DRA	184134	512 11.0 Ht	532 9.7 Jo	537 10.4 Pt
172809	180565	486 12.3 L	519 11.8 Ht	533 9.8 Jo	539 9.9 Fd
536 11.1 Pt	506 12.7 Pf	503 12.5 L	T CRA	535 10.0 Jo	AF CYG
537 11.1 Gy	518 12.8 Pf	537[12.5 Pt	*185537b*	537 9.6 Pt	192745
RT SER	537 13.0 Pt	R SCT	512 12.7 Ht	W AQL	505 6.9 Ah
173411	X DRA	*184205*	Z LYR	*191007*	511 7.1 Ah
486 12.9 L	180666	497 5.1 Cy	185634	537 13.2 Pt	513 7.1 Ah
516 12.9 L	518[12.9 Pf	506 5.5 Ar	537[13.0 Pt	T SGR	516 7.0 Ah
RU SCO	TV HER	508 5.1 Cy	SU SGR	*191017*	517 7.0 Se
173543	181031	509 5.3 Cy	*185722*	516 7.6 L	518 7.0 Se
516[13.1 Bl	486[14.0 L	510 5.2 Cy	512 8.5 Ht	537 8.0 Pt	528 7.0 Ah
SV SCO	RY OPH	513 5.8 Pt	519 8.5 Ht	R SGR	533 7.3 Ah
174135	181103	513 5.4 Jo	RT LYR	*191019*	TY CYG
516 10.0 Bl	537 12.6 Pt	514 5.7 Pt	*185737*	512 7.6 Ht	192928
W PAV	W LYR	514 5.7 Ko	503 10.3 L	516 7.3 L	531 10.1 L
174162	181136	515 5.8 Pt	R AQL	517 7.6 Me	537 10.3 Pt
516[13.0 Bl	486 10.3 L	516 5.9 Pt	190108	519 7.4 Ht	RT AQL
519[13.0 Ht	503 9.5 L	516 5.3 L	514 6.6 Ko	536 7.7 Me	193311
U ARA	505 9.7 Ah	517 5.4 Se	516 6.6 Ah	537 7.5 Pt	531 8.9 L
174551	511 9.2 Ah	517 5.9 Pt	517 7.0 Se	RY SGR	537 9.0 Pt
512 11.7 Ht	513 9.0 Jo	517 6.0 Cy	518 6.9 Se	*191033*	R CYG
519 12.4 Ht	516 9.0 Ah	517 5.9 Me	528 5.7 Ah	512 10.4 Ht	193449
RT OPH	522 9.0 Hf	518 6.0 Me	533 5.9 Ah	514 10.7 Pt	505 8.8 Ah
175111	528 8.5 Ah	518 5.6 Se	537 6.0 Pt	515 10.7 Pt	511 8.6 Ah
536[12.5 Pt	529 8.7 Hf	519 5.5 Se	V LYR	516 9.7 Pt	513 8.5 Jo
T DRA	532 8.3 Jo	520 5.9 Jo	190529a	517 9.7 Pt	514 8.5 Ko
175458a	533 8.4 Ah	521 5.9 Me	537[12.3 Pt	517 10.1 Me	516 8.9 Ah
535 9.2 Jo	535 8.0 Jo	524 6.1 Me	RX SGR	518 9.9 Me	517 8.8 Jo
RY HER	535 8.3 Wd	528 6.1 Me	*190818*	519 9.9 Ht	520 8.9 Jo
175519	535 8.2 Hf	532 6.3 Me	512 11.4 Ht	519 9.7 SR	522 9.0 Hf
536 11.5 Pt	536 8.0 Ra	536 6.4 Me	519 12.0 Ht	521 9.5 Me	528 8.7 Ah
V DRA	537 8.1 Pt	536 6.2 Pt	RW SGR	524 9.6 Me	529 9.0 Hf
175654	538 8.3 Jo	537 6.5 Pt	*190819a*	528 9.5 Me	532 9.6 Gy
536 12.7 Pt	539 8.0 Fd	537 6.7 Jo	512 11.1 Ht	529 9.5 Me	533 9.1 Jo
R PAV	SV HER	537 7.1 Gy	519 11.0 Ht	532 9.4 Me	533 9.7 Ah
180363	182224	538 6.5 Me	537 10.4 Pt	535 9.9 SR	535 9.6 Hf
512 8.1 Ht	486 10.0 L	538 6.4 Pt	TY AQL	536 9.3 Pt	536 9.6 Me
519 8.1 Ht	502 10.1 L	RW LYR	*190907*	536 9.6 Me	537 9.4 Jo
T HER	T SER	184243	532 10.3 Me	537 9.4 Pt	537 9.6 Gy
180531	182306	486 13.7 L	537 10.6 Pt	538 9.4 Me	538 9.1 Pt
486 7.1 L	513 9.9 Jo	503 14.2 L	X LYR	538 9.5 Pt	RV AQL
503 7.3 L	520 9.7 Jo	NOV AQL	190926	545 9.6 SR	193509
505 7.3 Ah	RZ HER	184300	537 9.1 Pt	S SGR	531 8.5 L
511 7.7 Ah	183225	507 10.5 Ar		*191319a*	538 9.1 Pt
516 8.2 Ah	486 11.3 L	520 10.9 Jo		519[12.7 Ht	

VARIABLE STAR OBSERVATIONS RECEIVED DURING APRIL, 1934.

J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.
TT CYG		RU SGR		RS CYG		ST CYG		T CEP		S CEP	
193752		*195142*		200938		202954		210868		213678	
477	8.0 Lt	512	7.2 Ht	472	8.4 Cy	538	11.5 Pt	502	6.6 Rb	538	10.7 Rc
490	8.0 Lt	519	7.5 Ht	477	8.5 Cy	V VUL		504	6.4 Ah	538	9.5 Pt
503	8.2 Lt	RR AQL		482	8.3 Cy	203226		505	6.5 Ah	RU CYG	
516	8.3 Lt	*195202*		513	7.2 Jo	538	8.6 Pt	506	6.0 Ar	213753	
532	8.1 Lt	531	8.9 L	514	7.3 Ko	S DEL		506	6.4 Kp	513	8.8 Jo
T PAV		NOV CYG		517	7.1 Jo	203816		510	6.2 Kp	517	8.9 Jo
193072		195553		520	7.2 Jo	531	10.5 L	510	6.3 Hf	520	9.2 Jo
501	10.0 Bl	514[12.2	Pt	522	7.6 Hf	538	11.0 Pt	511	6.1 Ah	537	9.3 Jo
512	10.5 Ht	537[12.2	Pt	524	7.2 Me	V CYG		512	6.4 Wd	RV CYG	
514	10.7 Bl	RR TEL		529	7.8 Hf	203847		512	6.0 Kp	213937	
519	11.3 Ht	*195656*		531	7.1 L	514	10.3 Ko	512	6.6 Se	538	6.6 Pt
524	11.3 Bl	512[12.8	Ht	535	7.9 Hf	520	9.7 Jo	512	6.4 Rc	μ CEP	
RT CYG		519[12.8	Ht	538	7.2 Jo	538	9.5 Pt	513	6.3 Ah	214058	
194048		Z CYG		538	7.0 Pt	T DEL		513	6.2 Kp	489	4.1 Lt
505	8.4 Ah	195849		R DEL		204016		514	6.0 Kp	516	4.0 Lt
511	8.5 Ah	538	12.8 Pt	201008		538[12.2	Pt	514	6.5 Pk	TY CEP	
513	8.3 Jo	S TEL		514	8.7 Ko	U DEL		514	5.9 Ko	215586	
514	8.5 Ko	*195855*		531	9.2 L	204017		516	6.1 Ah	505	11.2 Br
516	8.5 Ah	512	12.8 Ht	538	9.5 Pt	446	7.0 Lt	517	6.7 Sh	518	11.3 Br
517	8.2 Jo	519	12.8 Ht	SX CYG		464	7.2 Lt	517	6.4 Wd	TW PEG	
520	8.3 Jo	SY AQL		201130		477	7.1 Lt	517	6.2 Hf	215927	
522	8.8 Hf	200212		531	14.1 L	490	7.1 Lt	517	5.8 Jo	490	7.5 Lt
528	9.2 Ah	538[12.5	Pt	WX CYG		503	7.2 Lt	517	6.4 Se	503	7.7 Lt
529	9.1 Hf	S CYG		201437b		516	6.7 Lt	518	6.3 Se	516	7.5 Lt
532	9.3 Gy	200357		514	13.3 SR	V AQR		519	6.1 Rc	R IND	
533	9.5 Ah	537[12.8	Gy	524	12.6 Me	204102		522	5.8 Kp	*222867*	
533	9.5 Jo	545[12.8	SR	531	12.9 L	518	9.2 Me	525	5.8 Kp	501	9.2 Bl
535	9.5 Hf	S AQL		536	13.0 Me	538	9.6 Pt	526	6.0 Kp	514	8.8 Bl
536	9.4 Me	200715a		V SGE		T AQR		528	5.7 Pk	523	8.7 Bl
537	9.3 Jo	520	11.2 Jo	201520		*204405*		528	6.0 Ra	V CAS	
537	9.4 Gy	521	11.0 Me	514	11.7 SR	538	12.3 Pt	530	6.3 Ah	230759	
538	9.8 Pt	528	11.1 Me	517	12.2 Me	RZ CYG		531	5.9 Rc	513[12.5	Kn
TU CYG		531	11.3 L	518	12.2 Me	204846		532	5.6 Jo	517	12.2 Jo
194348		532	11.0 Me	521	12.0 Me	538[12.4	Pt	533	6.2 Ah	V PHE	
536[12.5	Me	536	11.0 Me	524	12.2 Me	X DEL		535	6.3 Kn	*233746*	
X AQL		538	10.5 Pt	528	11.5 Me	205017		535	6.4 Hf	471	9.4 En
194604		RW AQL		529	11.1 Me	538	11.8 Pt	535	5.8 Mc	Z AND	
531	12.9 L	200715b		532	11.3 Me	R VUL		536	6.4 Wd	232848	
538	12.4 Pt	520	8.9 Jo	535	12.1 SR	205923a		537	6.4 Kn	536	10.8 Me
X CYG		538	9.3 Pt	536	11.7 Me	513	12.2 Jo	538	6.0 Pt	Z CAS	
194632		Z AQL		538	11.5 Me	537	8.8 Jo	Y PAV		233956	
508	8.3 Cy	*200906*		545	11.7 SR	538	9.1 Pt	*211570*		517	9.7 Jo
513	7.8 Jo	494[13.0	Bm	U CYG		X CEP		519	5.5 Ht	RR CAS	
514	9.0 SR	531	12.6 L	201647		210382		W CYG		235053	
514	8.3 Ko	538	11.6 Pt	513	9.3 Jo	505[13.9	Br	213244		504[13.1	Bn
517	8.3 Cy	R SGE		517	9.3 Jo	512[14.6	Da	517	6.4 Se	R TUC	
517	7.9 Jo	200916		518	10.4 Me	533	14.8 Da	518	6.3 Se	*235265*	
520	7.9 Jo	517	9.8 Me	520	9.4 Jo	R EQU		S CEP		471	11.6 En
531	8.4 L	520	9.3 Jo	537	9.0 Jo	210812		213678		482	12.5 Sl
533	8.5 Jo	521	9.4 Me	539	9.5 Pt	538	10.1 Pt	505	10.2 Je	485	12.4 En
535	8.9 Hf	528	8.8 Me	Z DEL		T CEP		512	10.7 Wd	503	13.0 Ht
535	9.5 SR	532	8.7 Me	202817		210868		517	10.9 Kn	R CAS	
537	9.6 Gy	536	9.0 Me	539[12.9	Pt	480	6.2 Oy	531	10.6 Ra	235350	
537	8.7 Jo			ST CYG		501	6.5 Pk	536	10.4 Kn	517	12.4 Wd
538	9.8 Pt			202954		502	6.4 Kp	537	10.5 Kn	SV AND	
				537	11.2 Gy			537	9.6 Jo	235939	
										500	13.6 L

Rapidly Varying Irregular Variables.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
005840 RX Andromedae—													
	7499.7	13.5	Br	7510.5	13.5	GC		7513.6	11.5	Ko	7534.6	13.2	Me
	7500.3	13.1	L	7512.5	13.3	GC		7514.0	11.3	SR	7534.7	12.9	Md
	7501.4	13.1	Ry	7513.5	13.5	GC		7514.5	10.3	GC	7535.6	13.0	GC
060547 SS Aurigae—								7514.6	10.7	Ko	7535.7	12.9	Md
	7471.1	14.3	Bm	7521.7	11.5	Hi		7514.7	10.8	Pt	7536.6	12.6	So
	7479.1	14.3	Bm	7522.6	11.6	So		7515.6	11.5	Ry	7536.9	12.8	Me
	7481.1	14.8	Bm	7523.7	12.5	Hi		7515.7	10.6	Pt	7537.6	12.9	Me
	7482.6	12.5	Cy	7524.7	12.9	Hi		7516.7	11.0	Pt	7537.8	12.7	Gy
	7488.1	14.8	Bm	7525.6	13.5	Wp		7517.7	10.9	Pt	7538.6	11.5	Me
	7491.1	13.9	Bm	7525.6	13.4	Wa		7518.0	11.6	Me	7538.7	11.4	Pt
	7499.4	11.5	Ry	7526.7	13.2	Hi		7518.7	12.4	Br	7538.8	10.5	Md
	7500.7	13.9	Hi	7527.6	13.2	Wa		7519.0	12.2	Me	7539.0	11.0	Me
	7501.6	13.8	Ar	7528.6	13.0	B		7519.0	13.1	SR	7539.7	10.3	Md
	7504.6	13.2	Ry	7529.7	12.5	Pt		7519.8	12.7	Br	7540.7	10.4	Md
	7505.8	14.2	Da	7530.3	14.3	L		7520.7	12.9	Br	7542.7	10.5	Md
	7506.7	14.8	Br	7530.5	13.5	GC		7522.0	12.9	Me	7544.7	11.6	Md
	7507.6	13.8	Ar	7530.6	13.9	Wp		7530.5	12.6	GC	7545.8	12.2	Md
	7508.6	14.5	Pf	7530.6	14.0	Wa		7531.8	13.0	Md	7545.9	12.3	SR
	7508.6	14.0	Ar	7531.6	14.2	Wa		7532.6	13.2	Me	7546.8	12.6	Md
	7510.6	14.5	GC	7531.6	14.2	B		7533.7	13.1	SR	7547.8	12.8	Md
	7511.6	14.2	So	7532.7	14.5	Da		7533.8	12.9	Md			
	7512.6	14.5	GC	7533.7	13.2	SR	094512 X Leonis—						
	7513.6	14.5	Wa	7534.6	13.0	Me		7505.8	13.3	Br	7532.6	12.6	Me
	7514.5	13.9	GC	7535.6	14.0	Wa		7506.8	13.5	Br	7533.7	11.8	Pt
	7515.6	14.2	Ar	7536.5	13.2	So		7508.8	13.3	Br	7534.6	12.6	Me
	7516.6	14.1	Ar	7537.6	12.5	Jo		7510.7	13.3	GC	7535.7	11.8	Pt
	7517.7	13.9	Hi	7538.7	12.6	Pt		7513.6	12.3	SR	7536.6	13.3	So
	7518.7	13.2	Br	7540.6	13.2	Wa		7514.6	13.0	So	7538.7	12.3	Br
	7519.7	12.3	Br	7541.6	14.4	Wa		7518.8	13.3	Br	7539.7	12.5	Br
	7520.4	11.3	Ry	7541.6	14.3	Wp		7520.7	12.3	Br	7542.7	13.5	Br
	7520.7	11.5	Br					7530.6	13.0	So			
074922 U Geminorum—								7531.7	12.3	SR			
	7471.1	10.6	Bm	7514.5	13.8	GC	174406 RS Ophiuchi—						
	7473.0	9.0	Sl	7515.6	14.1	Ar		7486.7	12.1	L	7535.7	12.0	Wa
	7481.1	9.2	Bm	7515.7	14.2	Da		7512.5	12.2	Ht	7535.7	11.9	Wp
	7482.0	9.6	Sl	7516.6	14.0	Ar		7516.7	12.5	L	7536.9	11.8	Pt
	7482.7	9.0	Da	7518.7	13.3	Br		7519.0	12.3	Me	7536.9	11.6	Me
	7483.1	9.4	Bm	7519.7	13.3	Br		7519.5	12.4	Ht	7537.8	12.0	Gy
	7488.1	12.8	Bm	7525.6	10.9	Gy		7522.0	12.2	Me	7539.0	11.9	Me
	7491.1	13.6	Bm	7528.6	12.5	Me		7525.0	12.3	Me			
	7499.7	13.3	Br	7529.7	12.4	Pt	202946 SZ Cygni—						
	7501.6	13.7	Ar	7530.6	13.8	So		7513.9	9.7	Pt	7517.9	9.0	Pt
	7502.6	12.4	Ko	7531.7	13.3	SR		7514.9	9.7	Pt	7536.9	9.1	Pt
	7505.7	14.3	Br	7532.7	14.4	Da		7515.9	9.6	Pt	7537.9	9.5	Pt
	7506.7	14.2	Br	7533.7	13.3	Pt		7516.9	9.0	Pt	7538.9	9.5	Pt
	7506.7	13.9	Ar	7534.6	13.0	Me	213843 SS Cygni—						
	7507.7	13.9	Ar	7535.6	14.0	GC		7506.9	11.0	Ar	7533.0	12.0	Me
	7508.6	14.0	Ar	7536.7	13.3	Pt		7514.0	10.0	SR	7535.8	12.0	Wp
	7510.6	14.3	GC	7537.6	12.3	Mw		7514.9	10.1	Ko	7535.8	12.2	Wa
	7512.6	14.2	GC	7538.6	12.3	Jo		7516.5	9.9	Ah	7535.9	12.1	SR
	7513.5	14.1	GC	7539.6	12.2	Mw		7517.7	9.9	Jo	7536.9	11.7	Pt
081473 Z Camelopardalis—								7518.0	9.5	Me	7536.9	12.1	Me
	7479.6	13.0	Cy	7508.7	13.5	Br		7519.0	9.9	Me	7537.7	11.9	Jo
	7482.6	11.1	Cy	7510.6	13.0	GC		7519.0	10.2	SR	7537.9	12.0	Pt
	7501.4	13.2	Ry	7510.7	13.4	Br		7520.9	10.4	Jo	7538.9	12.1	Pt
	7504.6	12.9	Ry	7512.6	11.4	Ko		7522.0	11.4	Me	7539.0	12.1	Me
	7505.7	13.6	Br	7512.6	10.9	GC		7525.0	11.7	Me	7539.8	12.1	Fd
	7506.7	13.3	Br	7513.5	10.4	GC		7529.0	11.8	Me	7545.9	12.1	SR
	7507.4	13.0	Ry	7513.7	11.3	SR		7530.0	11.9	Me			

SUMMARY FOR APRIL, 1934.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	28	102	Meek	Me	37	135
Armfield	Ar	19	76	Millard	Md	3	14
Baldwin	Bl	66	141	Miller	Mw	20	31
Ballhaussen	Ba	4	5	O'Byrne	Oy	9	9
Bappu	Bm	27	70	Parthe	Pa	12	37
Bouton	B	52	78	Peltier	Pt	154	227
Brocchi	Br	28	73	Perkin	Pe	10	10
Brown	Bn	4	8	Perkinson	Pk	12	26
Buckstaff	Bc	2	4	Preucil	Pf	8	10
Cilley	Cy	22	48	Raphael	Ra	57	59
Davis	Da	24	52	Recinsky	Rc	12	34
Ensor	En	54	101	Rosebrugh	Rb	11	32
Ford	Fd	23	23	de Roy	Ry	7	19
George	Gg	5	5	Salanave	Sx	18	20
Georgetown	GC	29	73	Scanlon	So	32	77
Gregory	Gy	32	43	Schenkman	Se	13	24
Hartmann	Hf	65	155	Shinkfield	Sl	21	55
Hildom	Hi	10	25	Shultz	Sz	9	9
Houghton	Ht	74	159	Simpson	Si	2	8
Jansen	Je	7	11	Skora	SR	22	48
Jones	Jo	107	413	Smith, L.	Sh	23	30
King	Kg	9	21	Smith, F. P.	Sq	12	16
Kirkpatrick	Kp	4	31	Smith, F. W.	Sf	8	14
Kohman	Ko	33	53	Wade	Wh	2	2
Koons	Kn	8	33	Watson	Wa	22	51
Lacchini	L	120	173	Webb	Wd	51	140
Loreta	Lt	18	80	Williamson	Wg	4	7
Luechinger	Lr	5	5	Woods	Wp	21	46
McKnelly	My	12	16				
McLeod	Mc	7	7	Totals		58 390	3276

star activities were lessened but little due to the fact that he carried along a 4-inch telescope. Secretary Olcott has returned to Norwich, Connecticut, having spent the winter at Miami and Useppa Isle, Florida.

SU Tauri, after some hesitancy, has at last dropped to minimum, magnitude fainter than thirteen. R CrB appears to be fluctuating in a similar manner and may be expected to drop suddenly to minimum at any time. More than 3500 days have elapsed since the last minimum.

Observers with large telescopes at their disposal are needed to keep track of the faint novae. Identification charts will be supplied by the Recorder to competent observers upon request. Professor Recht has agreed to follow some of these with the 20-inch glass at the observatory of the University of Denver, Colorado.

LEON CAMPBELL, Recorder.

May 15, 1934.

The Reported Decline of R Coronae

In *Beobachtungszirkular 14*, April 18, 1934, Lause reports the beginning of a decrease of light of R Coronae. On April 14 he observed it approximately $0^{M}.5$ faint. In view of the great interest in this variable, which has shown no perceptible activity for ten years, my observations to date are recorded here.

Beginning in June, 1933, I have kept rather close watch of R Coronae, seldom letting a week pass, when the star was favorably situated, without at least a casual glance in its direction. No record was made except the notation "R CrB max,"

until February 27, 1934. Under that date in my notebook is the following record: "Suspect R CrB 0.1-0.2 magn. faint (nearly = b)." At that time comparison stars were selected as follows:

			M
a	B.D.	+32°2621	5.60
b		+32 2631	6.56

To date the following observations have been obtained:

1934 Feb.	Estimate	Magn.	Notes	1934 Apr.	Estimate	Magn.	Notes
27	a 7.0 R 3.0 b	6.27	moon	8	a 7.0 R 3.0 b	6.27	smoke
28	a 8.0 R 2.0 b	6.37	moon	9	a 5.5 R 4.5 b	6.13	
Mar.				16	a 7.0 R 3.0 b	6.27	
4	a 6.5 R 3.5 b	6.22		19	a 7.2 R 2.8 b	6.29	
8	max.	?	clouds	23	a 7.0 R 3.0 b	6.27	moon
10	a 3.0 R 7.0 b	5.89		27	a 8.0 R 2.0 b	6.37	moon
11	a 4.0 R 6.0 b	5.98		29	a 8.0 R 2.0 b	6.37	moon
12	a 3.5 R 6.5 b	5.94		30	a 7.0 R 3.0 b	6.27	haze
14	a 2.5 R 7.5 b	5.84		May			
19	a 3.0 R 7.0 b	5.89		1	a 6.0 R 4.0 b	6.18	
24	a 5.5 R 4.5 b	6.13		2	a 6.3 R 3.7 b	6.21	
27	a 6.5 R 3.5 b	6.22	moon	3	a 6.0 R 4.0 b	6.18	haze
28	a 7.0 R 3.0 b	6.27	moon	4	a 5.7 R 4.3 b	6.16	
Apr.				5	a 5.5 R 4.5 b	6.13	
4	a 6.0 R 4.0 b	6.18		6	a 5.5 R 4.5 b	6.13	
7	a 6.0 R 4.0 b	6.18		7	a 5.7 R 4.3 b	6.16	

The computation of magnitudes to hundredths goes well beyond the accuracy of the data, but the writer's experience has shown that rounding off to tenths is actually sacrificing something in the way of accuracy.

The decline of light referred to by Lause is obviously that which began late in March. It continued until about April 27, and since then the brightness has slightly increased. Looking farther back, however, we see that the variable was faint at the end of February. Whether the fluctuations exhibited are the preliminary stages of a great decline can best be answered a year from now. It seems possible at least that the recent activity is simply a slight increase in the amplitude of the minor fluctuations at maximum light, which have been suspected but not fully proven.

I should add that after the first three observations had agreed in showing the star faint, I was tempted to announce it, but excessive caution deterred me until, after a cloudy spell, the next observation showed the variable at maximum again, and about two weeks of maximum light practically convinced me that I was in error. As to the next decline, it is difficult to believe that two observers some thousands of miles apart would independently make series of several observations affected by similar trends to mere errors. In the main, the variations indicated, including the faintness in February, are now regarded by me as real.

DEAN B. MCLAUGHLIN.

The Observatory, University of Michigan, May 8, 1934.

Comet Notes

By G. VAN BIESBROECK

Cometary activity seems to have dropped to low ebb. The Jackson object discovered March 28 at Johannesburg has proved to be an asteroid moving in a highly inclined orbit. On the discovery plate it left a diffuse trail but subsequent observations showed that this was accidental and that the object was perfectly

sharp. Comet 1934*a* is therefore yet to be found!

Further photographic records of the two faint comets that were mentioned as being under observation last month, have been secured. PERIODIC COMET 1925 II (SCHWASSMANN-WACHMANN) showed again changes in its appearance during the month of May: it had brightened up in the first days of that month, reaching magnitude 14 and showing a well-defined edge. But soon the coma became larger in size: on May 8 the diffuse coma had almost doubled in diameter while the brightness had dropped to 15M. By May 18 no trace of the object could be found any longer on a plate showing stars of magnitude 16. Large fluctuations in form and brightness seem to be once more the rule with this comet which will be soon lost in the evening sky. But it can confidently be expected to be seen again next fall. COMET 1932*g* (GEDDES) slowly loses in brightness as expected from the data given on p. 259. Its presence was recorded here a couple of times in May but soon it will be too faint for further observations.

The return of the well-known PERIODIC COMET ENCKE is awaited by the end of June. For more than a century it has been observed at every return in its period of 3⅓ years. This time the perihelion passage is expected about September 16 but the geometric conditions are such that the object will appear as a morning object before that date. There have been unexplained fluctuations in the period of this comet. Its mean motion has steadily decreased in the course of the 19th century and the presence of a resisting medium in interplanetary space has been invoked for explaining this behavior. But since the returns in 1924 and 1928 the change has been in the other direction. L. Matkiewicz notes that the value of the mean motion has now come back to the value it had in the first half of the last century and expresses the hope that observers will watch the course of the comet both before and after perihelion this year, which brings a favorable opposition for northern observers. In view of the uncertainty as to the exact date of the return of the comet, A. C. D. Crommelin gives the following search ephemeris for two assumptions as to the time of passage through perihelion (*Handbook for 1934 of the British Astronomical Association*):

0^h U.T.	T (assumed 1934 Sept. 15.0)		T (assumed 1934 Sept. 17.0)	
	h m s	° ′	h m s	° ′
June 19	2 43 24	+22 52	2 40 24	+22 37
23	2 53 56	23 45	2 51 4	23 33
27	3 5 12	24 41	3 2 8	24 29
July 1	3 17 16	25 37	3 13 52	25 24
5	3 30 8	26 32	3 26 24	26 20
9	3 44 8	27 26	3 40 0	27 15
13	3 59 4	28 15	3 54 28	28 4
17	4 15 20	29 9	4 10 12	28 59
21	4 33 8	29 54	4 27 32	29 47
25	4 52 28	30 34	4 46 20	30 29
29	5 13 36	31 5	5 6 44	31 3
Aug. 2	5 36 36	+31 24	5 29 4	+31 27

Williams Bay, Wisconsin, May 21, 1934.

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

One of the purposes of these notes is to call attention to work done by others than members of the American Meteor Society. So it is particularly pleasing to mention the recent inauguration of a "Meteor News" section in the *Journal of the Royal Astronomical Society of Canada*, written by Dr. P. M. Millman. The

first five numbers, which have been read carefully here, give promise of a valuable addition to meteoric literature. Two of them are devoted to a discussion of Canadian observations during the Leonid shower of 1933. One finds a refreshing absence of useless or inconsequential details, while at the same time all the important data and conclusions appear. We may expect valuable meteoric work to be done in Canada from now on, and Dr. Millman is to be congratulated on the excellent organization of his first campaign as well as the published and probable future results.

At Flower Observatory we are pushing investigations on several brilliant fireballs. One thing is very striking: from some states nothing is ever received. As fireballs certainly are visible at intervals over every state in the country, this proves that, despite the tremendous increase in interest in recent years, large areas are still awaiting an active and intelligent person who will act as a local leader for the gathering of data. I heartily recommend this work to amateur astronomers as being both useful to science and personally interesting. Speaking of this need brings to mind a matter directly bearing upon it, which will be discussed at some length.

During recent years there have been many statements by certain American investigators which tended to throw grave doubts on the accuracy of fireball heights derived from data obtained by letter and questionnaire. If the criticisms remained wholly unanswered, it would make amateurs and the general public believe that their reports were of little or no value unless they could later be personally interviewed. As I take positive exception to any such contention, and believe that the spread of such a doctrine would greatly harm meteoric astronomy, occasion is now taken to reply to certain statements bearing upon a paper of my own,[1] the data for which were secured in the usual way, by correspondence. Although this direct reply is to statements by Professor C. C. Wylie appearing in POPULAR ASTRONOMY for May, 1934, it will serve also the wider and more useful purpose of clarifying the general question at issue. Professor Wylie's statements are based upon a discussion of results published by him in 1929[2] and by me in 1931,[1] both papers dealing with the great Illinois fireball of 1929 July 25.

To compare one's own work with that of a fellow scientist is at best an ungracious task, and one to be avoided if possible. Yet for this question, only by such comparison can probable truth be found. Neither of us saw the fireball, but my colleague, Dr. S. G. Barton, did see it, as he was at Yerkes Observatory. His most efficient help in securing and interpreting the observations aided me greatly. Professor Wylie's paper is dated only 72 days after the appearance; mine, two years later. During that interval the investigation was taken up again and again; it was studied and restudied; and other members of the Flower Observatory staff were called on for aid. The number of reports was over 400, not including follow-up replies; Professor Wylie mentions reports from 10 states, but no estimate of number of observers. He also wholly failed to detect (or at least mention) the other bright fireball seen over Lake Michigan 32 minutes sooner. Had his reports been complete, this could hardly have been missed.

It is regrettable that he did not read my article more carefully, for he states, "His determination of the path was based altogether on information obtained from correspondence, and chiefly on information obtained from Chicago." Actually the beginning point was obtained from the Chicago estimate *plus* 40 others from 4 states. The end point was fixed by observations from 3 people living in the

[1] POPULAR ASTRONOMY, **39**, 521-526, 1931.
[2] POPULAR ASTRONOMY, **37**, 514-519, 1929.

town of Crystal Lake, Illinois, two of whom reported it NW and one W at the time of disappearance; by Milwaukee observers, who gave a point even farther to the N; and by a man near Hebron, Illinois, who checked the Crystal Lake observers. The average of the numerous Chicago observations fitted this point excellently, as did the observations at Yerkes Observatory and near-by Wisconsin stations. The Yerkes and Wisconsin groups, however, were more valuable for fixing the azimuth and slope, as they were almost in the plane of motion. For Professor Wylie to be right in his location of the end point, the Crystal Lake observers would have to be nearly a quadrant out; and they saw it come from the SW also. As these people were nearest the end point, their observations deserve weight. Professor Wylie, by his own statement, had only one observer anywhere near his adopted end point: we had several besides those in or near Chicago, whose observations in many cases proved familiarity with the constellations and angular estimates.

A partial explanation of Professor Wylie's difficulties was afforded by our own records: they indicated that the farther from the end point the observer was, the greater his end height. But the real source of disagreement was clearly explained in my original paper: most of Professor Wylie's observers were farther away, and they—like our own distant observers—either intentionally took the explosion point as being the end point, or remembered it as such. Many reporting to us, most of them nearer the path than his observers, described fragments as continuing after the explosion, not so bright nor so large as the original object. It was the place at which these fragments disappeared that I determined as the end point. The points determined by the two calculations were hence necessarily different: one was the explosion point, one the end point. Professor Wylie also states that my lower height was improbable because no detonations were heard: an examination of my article will show that detonations were reported to me.

It is needless to compare other points in the two articles. Almost certainly Professor Wylie based his paper on far fewer observations and with less time spent in critical examination and calculation. As a result, in his six-page article the only essential data actually given are the end height and a possible velocity —though one can deduce additional data from his diagram by some calculation— while the radiant point and orbit are not even mentioned. If he had any confidence in the rest of the deducible data, why were they not given? The advantages he secured by a limited number of conversations were outbalanced by our 400 or more reports, the best of which were followed up by questionnaires or letters, and some of which were made by observers who plotted the path among the stars. Several observers also sent me detailed drawings showing how the smaller and fainter fragments kept going farther to the N after the main explosion. On the whole, the example chosen by Professor Wylie to illustrate his points (that the path is ordinarily reported unduly long, and that excellent results cannot be obtained through correspondence alone) turns out to be an unfortunate one for the purpose.

For the many fireballs studied here, practically all by mail, the results have ranged from excellent to no solutions, with all gradations between. The trained investigator, who has in addition personally observed for many years, learns by experience, and by taking time for continued approximations, how to work out results of value from data which at first may seem almost hopeless. He will also on publication be careful to state the probable correctness of his deductions, which will differ greatly for different meteors. Under such circumstances his results will compare favorably, as to percentage of probable error, not only with the av-

erage investigation in stellar astronomy but even with the corner-stone of it all—the direct determination of the parallaxes of stars.

The main purpose of this discussion is not merely to justify the methods personally used, but much more to give a note of warning against a procedure which, because of its most restricted applicability, would greatly handicap and retard advances in meteoric astronomy, and would discourage others from taking up the work of regional leadership recommended earlier in this article.

Meteor Heights, 1933 Leonid Epoch

CONTINUATION OF PART II. STATE GROUPS.

By DORIS M. WILLS

The accompanying table gives 20 heights deduced from observations last November at Boulder and Denver, Colorado. These heights were computed by the graphical altitude-azimuth method described in *A.M.S. Reprint* No. 11.

Professor A. W. Recht of the University of Denver was group leader for the two stations. The personnel for the observations for heights was organized as follows:

Station—Denver. Group—Beta Chapter, Alpha Nu Fraternity, under Professor A. W. Recht. Observers—Plotting: A. W. Recht, C. J. Erickson, A. W. Beck, E. Schaetzel. Recording and Timing: Miss S. Petrie, Miss S. Gessell, H. Lee, A. Gessell.

Station—Boulder. Group—Alpha Chapter, Alpha Nu Fraternity, under Dr. J. M. Blair. Observers—C. Spessard, D. C. Spencer, H. McJunkin, E. McNatt, Miss L. Roloff, D. Billings, C. Pydock, W. Jacoe.

No.	Date 1933 Nov.	Time M.S.T.	Ave. Est. Mag.	Beginning Height km.		End Height km.		Class (Leonid or Sporadic)
1	14-15	12:49:32	1	62±	2[1]	38±	4	S
2		13:37:05	2.5	117	2	64	3	S
3		13:47:53	1	96	5	81	3	S
4		14:07:00	0.5	114	13	75	1	S
5		15:00:38	2.5	140	43	102	19	S
6	15-16	12:41:28	2.5	150	2	111	3	S
7		12:46:03	2	56	5	50	10	S
8		12:53:02	1.5	109	5	81	15	S
9		13:04:42	2.5	93	9	35	2	S
10		13:07:52	2.5	157	29	124	10	S
11		14:25:00	2	204	12	83	2	L
12		14:30:21	2	..	..	158	10	S
13		14:41:14	2.5	175	10	81	3	L[2]
14		14:48:16	1	..	..	52	1	L
15		15:27:02	2	150	5	82	16	S
16		15:47:29	1.5	146	7	..	..	L
17		15:58:30	3	97	16	46	10	L
18	16-17	13:48:23	2	80	9	80	12	S
19		14:36:46	1.5	89	0	109[2]	0	L
20		14:51:38	2.5	117	12	80	11	S?
Mean Heights for Sporadic Meteors only				110.8		82.9		

[1] Average deviation from the mean; not "probable error."

[2] Rising meteor; at least one end obviously wrong, but average deviations negligible. Time difference, 2 seconds.

The Denver observers were so fortunate as to have at least two plotters on each night. Three observers plotted paths for meteors 16, 17, and 18; two observers plotted 1, 2, 3, 4, 5, 10, 11, 12, 13, and 20. As some of the plotters were more experienced than others, the observations were weighted before being com-

bined. The average deviations from the mean were about 3 degrees in right ascension and 1½ degrees in declination for each end of the path. W. P. Warner, from an investigation of probable errors of plots made by Texas observers in 1929, concluded that a difference of about 5 degrees in the plotted position of either end was commonly found.

The timing for these two stations was the most concordant we have ever seen. Both stations recorded the second at which the radio announcer at KOA in Denver in signing off for the night pronounced the syllable *cy* of the word "kilocycles." The correction of the Boulder times with respect to the Denver ones was thus found. From the unusual accuracy of the recorded times of meteors simultaneously seen from both stations, we are led to believe that this method of synchronizing watches is excellent. Much credit for accurate timing must also be given to the timers. The average recorded difference in time for the meteors given in the table was 2 seconds; only two of the twenty meteors had recorded differences of more than 3 seconds, and those were 8 and 9 seconds. The Denver observers used a stop watch.

Not only the timing deserves commendation: even a glance at the deviations listed in the table will show that many of the meteors were unusually accurately plotted. The median percentage value of the deviations for these twenty meteors is about 6 per cent for each end, and the average about 9 per cent. Excellent organization of the two groups and careful preliminary training for most of the plotters are mainly responsible for the unusual results obtained.

Heights for meteors observed during the 1933 Leonid epoch by the Ohio and Kentucky-Tennessee observers will probably be published in the next issue of POPULAR ASTRONOMY.

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1934 May 18.

An Estimate of the Mass of Meteors

By C. C. WYLIE

For more than fifty years astronomers and physicists have been making estimates of the masses of meteors. The amount of light given off by the meteor is known approximately. The energy corresponding to this light can be computed, assuming certain wave-length distributions. The velocity of the meteor is also known approximately, and from this velocity the total kinetic energy can be computed in terms of the mass. If now we knew the fraction of the total energy which is converted into light, the mass of the meteor could be computed. Professor C. A. Young, in his General Astronomy, copyrighted in 1888, states:

"It is not likely that this factor exceeds *one hundred* or is less than *ten*."

Using the observations made by Professors Newcomb and Harkness, in 1866 and 1867, Professor Young found that the majority of the meteors observed probably weighed less than 65 milligrams and that the largest weighed less than 6½ grams. According to Professor Young's estimate, the average shooting star is smaller in size than a grain of wheat.

In more recent years estimates have been made by Sparrow, Lindemann and Dobson, Maris, and Öpik. According to the work of Lindemann and Dobson, (*Proceedings of Royal Society*, Vol. 102, p. 111 ff, 1923) a second-magnitude meteor weighs about 2½ milligrams. Sparrow, however, pointed out an error in the work of Lindemann and Dobson, and Öpik agrees with Sparrow that the error

is there. According to Maris (*Terrestrial Magn.*, Vol. 34, 309 ff. 1926) a typical second-magnitude meteor weighs about 25 milligrams. According to Öpik (*Harvard Reprint* No. 100) a typical second-magnitude meteor in the zenith, weighs about 12 milligrams.

Some investigators, however, believe that these physical results are much too small. Professor W. H. Pickering published in the *Astrophysical Journal* in 1909, an article in which he estimated that the average meteor is perhaps six or seven inches in diameter. Later, in POPULAR ASTRONOMY for January, 1933, he revised this estimate, having reached the conclusion that the assumptions made were not correct. In this article he gives it as his opinion that, with only the brightness and the velocity of a meteor, the information is too scant to apply the principle of the conservation of energy. In other words, he did not believe that we can make an intelligent estimate of the fraction of the total energy which is manifested as light. According to Professor Pickering's revised estimate, a meteor of magnitude —2 is between two inches and six inches in diameter.

H. H. Nininger, of the Colorado Museum of Denver, in his book, "Our Stone Pelted Planet," expresses the same viewpoint as Pickering. On page 89 of this book Mr. Nininger states:

> "We also know from a study of fallen meteorites that their enveloping crust of fused material is in most cases about five-tenths of a millimeter in thickness; this, then, can be relied upon as a fair estimate of the depth on the surface to which a falling meteorite is being continually reduced to a liquid condition and constantly removed by the powerful air currents which sweep over its surface."

He adopts five pounds as the weight of the average meteor, including shooting stars.

It has occurred to us that where meteorites are recovered, we have some observational data bearing on the mass. By comparing these largest meteors with ordinary shooting stars, the masses of the latter can be estimated. Most of the theoretical work of the usual methods can be avoided. For some of the observational data, only rough estimates are at present available, but they should give results of the right order of magnitude. We will use two falls where for each about 800 pounds of meteorites were recovered.

From reports of observers we know that when the Amana (or Homestead) meteor fell in 1875, the landscape was lighted up so that it seemed as bright as day to people outdoors. When the Paragould meteor fell in 1930, persons who were outdoors were similarly impressed with the brightness of the light. For either of these meteors the illumination must have been much more intense than for the ordinary detonating meteor. For two recent detonating meteors which fell on moonlight nights, we have had a number of observers estimate the light from the sharpness of the shadows. We asked them to base their estimate on the general illumination and sharpness of the shadows in the light of the full moon, and also in bright daylight. The estimates indicate that these meteors, from which no meteorites have been recovered, were approximately of magnitude —16, and we have adopted magnitude —20 for the Amana meteor. The light of the Paragould meteor was probably about the same as for the Amana meteor.

We know from the reports of observers that bright detonating meteors do not usually attract attention until they reach a height of about 55 miles. The average shooting star is most conspicuous at a height of about 70 miles. Occasionally we find someone who happened to be looking up when a brilliant meteor first appeared. These people say that when first seen the meteor looked like a bright

shooting star. As it went lower, the brilliancy increased until it was a spectacular fireball. Such meteors must at their best be fully five magnitudes brighter than they were at the height of the ordinary shooting star. The Amana and Paragould meteors were, therefore, on this estimate, of magnitude —15 at a height of 70 miles.

We know from the reports of observers that the Amana and Paragould meteors travelled much more slowly than the ordinary shooting star. From a study of physics it is known that the kinetic energy varies as the square of the velocity. Presumably the light of a meteor would vary approximately, but not exactly, in that way. Let us assume that the Amana and Paragould meteors were two magnitudes fainter because of travelling at a lower velocity. On this estimate a meteor of the same mass as the Amana or Paragould and travelling with the velocity of an ordinary shooting star, would have been of magnitude —17, at a height of 70 miles. A meteor of magnitude —17 is 19 magnitudes brighter, or 40 million times as bright as a second magnitude meteor. Let us now make an estimate of the mass for these large meteors.

The Amana meteor fell in February, with several inches of snow on the ground. About 800 pounds of meteoric material were recovered. The larger meteorites, however, fell in an area which included the bottom lands of the Iowa River. This land was covered with timber and brush and without doubt a considerable number of the larger stones were never recovered. Students of meteors and meteorites are agreed that only a fraction of the original mass of such a meteor reaches the earth. Let us adopt ten thousand pounds as the mass of the meteor in the upper atmosphere. At Paragould, in Arkansas, about 880 pounds of meteoric material were recovered. There is evidence that another large stone was not recovered. Let us use ten thousand pounds as the estimate for this meteor also.

Let us assume now that at a height of 70 miles, the same fraction of the total energy is converted into light for the ordinary shooting star and for a meteor of the mass of the Amana or Paragould meteors, if travelling at the same velocity. On this assumption the mass of a second-magnitude shooting star is one forty-millionth (1/40,000,000) that of these large meteors. With our estimate of 10,000 pounds for the large meteors, the mass of a second-magnitude meteor is 114 milligrams. If made of iron, it would be one-eighth of an inch in diameter. It would be about twice the diameter of an ordinary pin head.

This is larger than the recent physical estimates of Maris and Öpik, but of the same order. It is much smaller than the estimates of Pickering and Nininger. Öpik assumes that the shooting star at a height of 70 miles is shining by impact radiation. Collisions of air molecules with the front of the meteor, are responsible for the radiation. The meteor is not yet heated sufficiently for a real temperature radiation. If the meteor is large enough to go lower, temperature radiation does become important. According to Öpik's theory, the melting and brushing off of the surface as described by Nininger for meteorites does not occur for the shooting stars.

As a check on this result we have calculated the mass which a meteor as bright as the full moon (magnitude —12.6) should have. We find that such a meteor probably weighs about eleven pounds. This mass agrees with the observed fact that, although we are regularly investigating fireballs of that brightness, meteorites have not in our experience been recovered unless the meteor is reported distinctly brighter than the full moon. It seems reasonable to assume that unless a meteor is larger than eleven pounds, little or nothing would reach the surface

of the earth.

As another check, we have computed the masses of the large meteors on the assumption that shooting stars are of the size a person would instinctively assume. Let us assume that a second-magnitude meteor weighs from one to five pounds, and that for large meteors the same fraction of the total energy is converted into light as for the second-magnitude. With these assumptions a meteor of magnitude —20 would weigh from twenty thousand to one hundred thousand tons. This weight appears quite impossible. From the force of the explosion on June 30, 1908, Whipple computed the mass of the meteor which produced the craters in Siberia. This result was 130 tons, assuming a velocity of forty miles per second. We doubt whether any observed meteors have had over a fraction of the mass of the big Cape York (36½ tons) meteorite.

To summarize: We have assumed in this paper that the same fraction of the total energy is converted into visible radiation for ordinary shooting stars and for the largest observed meteors, provided they are travelling at the same height and at the same velocity. This leads to masses for the ordinary shooting stars, of the same order of magnitude as derived from physical theory. Permissible changes in the adopted data would make the agreement exact. For a typical second-magnitude meteor of iron, our diameter is ⅛ inch, or twice that of an ordinary pin head. The small size is in itself a confirmation of the physical theory that the radiation from the ordinary shooting star is from atomic collisions rather than from temperature.

University of Iowa, April 25, 1934.

Notes from the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD, President, and H. H. NININGER, Secretary

A New Meteorite from Colorado—The Detonating Meteor of April 8, 1934

By H. H. NININGER

All those who have set out in search of meteorites are acquainted with the many disappointments which attend the efforts of a searcher after these rare immigrants to our planet. In every mail the writer is notified of the existence of new "meteorites," which, upon the arrival of samples, prove to be anything from common limestone to commercial coke!

The reader may imagine, then, the thrill which accompanied the writer's recent visit to a ranch in eastern Colorado, where he was shown an almost complete sixty-pound stony meteorite, very well oriented and beautifully pitted. The stone is old and discolored, but it is a very attractive specimen in spite of its alteration.

A visit to the spot in the cornfield where the farmer's lister had encountered the stone proved that it had been originally buried to a considerable depth, but a "blow-out" in the sandy soil had lowered the surface level to a depth of about 3½ feet, where a corner of the stone had been exposed.

The location is about five miles southwest of Weldona, Morgan County, Colorado.

This is the fourth stony meteorite from the State of Colorado.

On April 8, 1934, at about 8:40 P.M., M.S.T., many persons throughout Nebraska, Kansas, and Colorado witnessed a large fireball descending from the north-north-east, over the north central part of Nebraska. Several persons reported detonations.

A brief survey, in the course of which witnesses were interviewed on all sides of the fall, proved that the meteor came from slightly east of north, descending at an angle of about 30° with the horizontal, and disappeared at an altitude of several miles over the southern part of Thomas County, Nebraska. A scattering of sparks at the end indicated that the meteor burst into many fragments. No fragments have been found to date.

Bibliography of Meteoritics: Third 1934 List

By Frederick C. Leonard and Robert W. Webb

This is a continuation of "Recent Research Literature on Meteorites—Second 1934 List," published in these *Notes* in *P. A.*, **42**, 226-7 (April, 1934). In order that these enumerations may be as complete as possible, and represent all the current literature in the field of meteoritics known to the compilers, it has been decided to include, in the present and in future bibliographies, the titles of general and popular, as well as research and technical, publications, and also of contributions which have appeared in Popular Astronomy—even those published in the *Notes from the Society for Research on Meteorites* (abbreviated *N.S.R.M.*). The large majority of the publications listed here are, however, of a research or an original character. It has been decided likewise, for facility in reference, to number serially all the titles enumerated in the bibliographies of any year; accordingly, the first number assigned in the present list is 57 (since 56 titles are contained in the two prior lists: see *N.S.R.M.*, *P.A.*, **42**, 106, and 226-7, 1934).

The compilers will appreciate information concerning any titles omitted from these bibliographies. They would explain, however, that they are aware that the three lists now published are incomplete to date, a considerable number of titles being still available which could not be included in this and the earlier bibliographies but which will be embodied probably in subsequent ones.

Attention is called to the *Bibliography of North American Geology, 1931 and 1932* (United States Department of the Interior *Geological Survey Bulletin 858*), ii +300 pp., by John M. Nickles: Index, headings "Meteor Crater" and "Meteorites," p. 260, and Bibliography, by authors' names, in the main part of the compilation. This and its companion volumes are valuable catalogs of their subject material.

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List of New Members of the Society

Continued from the list in the *N. S. R. M., P. A.*, **42**, 47 (January, 1934)

E. L. Chapman, 4567 Meadowbrook Drive, Fort Worth, Texas.
Dr. W. A. Chatterton, 2030 E. Washington St., Pasadena, California.
Thomas H. Cisler, Marietta, Ohio.
Professor L. J. Corbly, Head, Department of General Lectures on Astronomy, Huntington, West Virginia.
Frank Clay Cross, 1114 Downing St., Denver, Colorado.
Robert O. Grimm, 338 E. 92nd St., New York, New York.
Dr. Z. T. Huff, Dean, Wayland College, Plainview, Texas.
L. V. Kenkel, 112 S. Orange Drive, Los Angeles, California.
Professor Mohammad Abdur R. Khan, Department of Physics, Osmania University College, Hyderabad, Begumpet, Deccan, N. S. R., *India*.
Dr. Horace C. Levinson, 4049 Lake Park Ave., Chicago, Illinois.
Dr. Professor F. K. G. Müllerried, 2a del Volga 18, México, D. F., *México*.
Richard M. Pearl, 4069 Beniteau Ave., Detroit, Michigan.
J. Wesley Simpson, 639 Locksley Place, Webster Groves, Missouri.
Ira L. Strom, Box 185, Montevallo, Alabama.
Louis Vésignié, 22 Rue du Général Foy, Paris (8e), *France*.

Robert Wallace Webb, Department of Geology, University of California at Los Angeles, Los Angeles, California.
Franklin E. Wolfe, 814 Neil P. Anderson Building, Fort Worth, Texas.

Copies of Farrington's Book on "Meteorites" for Sale

More than four hundred copies (all the remaining stock) of the classical work on *Meteorites:* their Structure, Composition, and Terrestrial Relations, by Oliver Cummings Farrington, Ph.D., late Curator of Geology in the Field Museum of Natural History, Chicago, Illinois, and late Honorary President of this Society, published by the author in 1915 (x +233 pp.), have been recently acquired by the Society from Mrs. Farrington and are on sale at the Secretary-Treasurer's office, 1955 Fairfax Street, Denver, Colorado, to members of the Society for $1.50 per copy and to non-members for $2.00 per copy, post-paid, to any part of the world. Members and others who desire to purchase copies of this valuable volume, at the aforesaid low prices, should send their order, accompanied by remittance, to the Secretary-Treasurer.

The Second Annual Meeting of the Society

The attention of members and others interested is called to the announcement in our *Notes* in the current May number concerning the Second Annual Meeting of the Society, to be held in connection with the summer meeting of the American Association for the Advancement of Science, at the University of California in Berkeley, on Monday, June 18, and Wednesday, June 20, 1934. There will be two sessions on each of these days, one convening in the morning at ten o'clock, the other in the afternoon at two o'clock. All members who can attend, or who can contribute to the program of the meeting, are cordially invited to do so, and should communicate at once with the Secretary.

Secretary's Address: The Nininger Laboratory, 1955 Fairfax Street, Denver, Colorado.

Editors' Address: Department of Astronomy, University of California at Los Angeles.

Notes from Amateurs

Astrolab Progress Report

There has been considerable correspondence among our members regarding the new sunspot activities. Three widely scattered groups of sunspots are visible today, one medium sized spot, two large spots very close together, and three small spots south of the equator—soon to disappear around the west limb of the sun. These spots have been observed here in our 8-inch sun mirror of 70 feet focus. The sun's image being about 7 inches in diameter, many details are visible which cannot be so well seen in a smaller image. Flames seem to leap out from the edge of the sun as from a burning ball and travel in a counter clockwise direction—an illusion no doubt, as we estimate the flames would be about 3,000 miles high, and vary from minimum to maximum more than once per second.

First Impressions of an 11-inch Telescope of 40-inch Focus

The Polar Bowl Mounting, an all aluminum telescope weighing about 70 pounds equipped with our 11-inch mirror shows the moon at first quarter nicely during the daytime using 70 power. First difficulties were: Inaccurate line up of optical train, but good collimation was finally obtained after increased experience with this new mounting; Collimation is much more critical in an F3.6 than in the conventional long-focus telescopes; The diagonal flat used to direct the cone

of light rays to the eyepiece must be much more nearly accurate on such short-focus telescopes than on the long focus, because it is larger, and proportionately farther inside of focus. These difficulties are offset by the ease of use of an 11-inch telescope which is actually "portable."

This Polar Bowl as a Newtonian is particularly suitable for a comet hunter, for comparing variable stars, and viewing nebulae. It will be compounded as a Gregorian for splitting close doubles and viewing planetary detail. A second tube, interchangeable with the Newtonian, is being assembled for Gregorian use.

Continued development and refinement of detail is being made as the five incomplete Polar Bowls are brought closer to completion.

The new ¾-inch Kellner eyepiece mounting weighs less than one ounce, assembled. It is made of aluminum and cellulose acetate and incorporates the best engineering design details.

The slide making committee have made over 100 slides, which are now being bound and labeled.

Telescopic observation of the Perseid Meteor Shower is a part of the summer plan of coöperation with the American Meteor Society, The Midwest Meteor Association, and the Joliet Astronomical Society. See previous issues of POPULAR ASTRONOMY for further details of Astrolab's activities.

L. I. BUTTLES.

10728 S. Artesian Avenue, Morgan Park, Chicago, May 22, 1934.

Amateur Telescope Makers of Chicago

The Amateur Telescope Makers of Chicago held their monthly meeting on Sunday, May 6, at the Adler Planetarium and Astronomical Museum, Chicago.

Professor Arthur Howe Carpenter called the meeting to order and disposed of the usual business matters.

Dr. Philip Fox, director of the Planetarium gave an address entitled "I have made a telescope, what can I do with it?" The title was paraphrased on a booklet written by Dr. Fox during the war, "I have found a machine gun, what can I do with it?" This booklet contained clear concise directions in the use of captured machine guns so that these weapons might be put in action at once.

Dr. Fox applied the same treatment to the amateur and his telescope, describing the branches of astronomy in which the amateur could do useful work and outlining the methods to be used: Observation of sunspots, Occultations by the moon, Selenography, Study of the planets, and Variable star work.

The beginner is apt to think that all the important work is done with the large telescope at the observatories but Dr. Fox told us of many ways to use our modest instruments in scientific work which would be of much value.

It was a most inspiring talk and the amateurs should work at finishing and using their telescopes with renewed enthusiasm.

1319 W. 78th Street, Chicago, Illinois. WM. CALLUM, *Secretary.*

Zodiacal Light Notes

By FRANKLIN W. SMITH

The evening Zodiacal Light has now crossed the Milky Way and is again in a favorable region for observation. Unfavorable weather conditions, however, have prevented it from being seen at this station except on one or two occasions. On May 12 at 9:15 E.S.T., the light cone was traced eastward to an apex near

Regulus. The northern boundary passed near Pollux and a degree or two north of γ Cancri. The southern boundary passed through points about 8° north of Procyon and 1° north of α Cancri, respectively. The axis of the light cone was therefore practically coincident with the ecliptic and the elongation of the apex from the sun was about 96°.

The Gegenschein is now too far south to be well seen by northern observers. It could not be seen here at 11:00 on May 8, although the sky was very clear at the time.

407 Scott Ave., Glenolden, Pennsylvania, May 17, 1934.

General Notes

Dr. A. A. Belopolsky, astrophysicist and at one time director of the Pulkovo Observatory, near Leningrad, Russia, died on May 16, at the age of nearly eighty. Dr. Belopolsky was a collaborating editor of the *Astrophysical Journal* since 1902. He was well known for his studies of the radial velocities of the stars, and especially for the first experimental verification of Doppler's principle in the laboratory.

Dr. George Cary Comstock, director emeritus of the Washburn Observatory and professor of astronomy in the University of Wisconsin, died on May 11 in his eightieth year. An account of Professor Comstock's contributions to astronomy is being prepared by Professor Joel Stebbins for a later issue of POPULAR ASTRONOMY.

Dr. Edwin P. Hubble, of the Mt. Wilson Observatory, gave the evening lecture before the National Academy of Sciences on April 23. His subject was "The Realm of the Nebulae." (*Science,* April 27, 1934.)

Dr. J. Hartmann, since 1922 director of the Observatory of the National University at La Plata, Argentina, has asked to be relieved from this post on account of failing health, and Ing. Félix Aguilar has been elected by the University authorities to succeed him. Ing. Aguilar was in charge of the Observatory from 1915 to 1920 and since 1922 has been chief of the division of geodesy of the Instituto Geográfico Militar, in Buenos Aires. Dr. Hartmann will return to Germany.

The Rittenhouse Astronomical Society of Philadelphia held its monthly meeting in the Hall of The Franklin Institute, Twentieth Street and the Parkway, Tuesday evening, May 8. The program was an address on "The Ritchey-Chrétien Telescope of the U. S. Naval Observatory," by Captain J. F. Hellweg, Superintendent of the U. S. Naval Observatory.

Planetarium for the Naval Academy at Annapolis.—According to a recent announcement plans are being laid for the erection of a planetarium at the United States Naval Academy. This planetarium would be intended primarily for instruction in navigation, but the cities of Washington and Baltimore would be near enough to avail themselves of it also. It is reported that the planetarium in Rome is in use regularly for giving instruction to the navy personnel and to students.